PUBLIC HEALTH.

NINTH REPORT

OF

THE MEDICAL OFFICER OF THE PRIVY COUNCIL.

WITH

APPENDIX.

1866.

Presented pursuant to Act of Parliament.

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TO THE LORDS OF HER MAJESTY'S MOST HONORABLE PRIVY COUNCIL.

My Lords,

In obedience to the Public Health Act, 1858, I have the honour of herewith submitting to your Lordships, for presentation to Parliament, my Report of the proceedings which your Lordships under that Act directed to be taken during the year 1866.

I am, my Lords,
Your Lordships' obedient servant,
JOHN SIMON.

Medical Department of the Council Office;
8, Richmond Terrace, S.W.,
March 31st, 1867.

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MEDICAL OFFICER'S REPORT.

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THE proceedings taken in 1866 by the Lords of the Council, acting under the Public Health Act, 1858, may conveniently be distinguished into two classes:—1) proceedings under the *ordinary powers* which that Act confers, and (2) proceedings under the *extraordinary powers* which the first section of the Act enables their Lordships to exercise, by putting the Diseases Prevention Act in force, at times when the country is "attacked or threatened by any formidable epidemic, endemic, or contagious disease."

I. ORDINARY PROCEEDINGS UNDER THE PUBLIC HEALTH ACT.

SUMMARY STATEMENT.

Under the first head I have to state as follows:—

a) that the superintendence of public vaccination,* and of the supply of vaccine lymph,† and of educational vaccinating stations, was continued as in previous years; and that in addition my Lords now began to administer a grant of public money, with which Parliament had entrusted them, for rewarding, in a mode which I will hereafter more particularly describe, local officers who show particular merit in conducting the vaccination of their respective districts:

b) that the inquiries, both systematic and occasional, by which their Lordships for many past years have empowered me to study the distribution of disease in England, and the circumstances by which it is regulated, were continued; particularly that the inquiry begun in 1865 into the results produced on the public health by works of drainage and water-supply, and certain other changed local conditions, has, as I shall presently describe, led to some very important conclusions; further, that the pathological (chiefly chemical) investigations, adverted to in my last report, made progress; and that, besides these systematic studies, occasional

* During the year 900 vaccination districts, comprised in 158 different unions or parishes, were inspected by their Lordships' inspectors, Drs. Seaton, Stevens and Hunter. The fourth of the present inspectors, Dr. Brodribb, did not enter on his engagement till January 1st, 1867, and Dr. Hunter was acting in this capacity only for about five months of 1866.

† In answer to 17,929 applications made during the year for vaccine lymph, there were supplied, under their Lordships' orders, 127,960 charged ivory points, 1,500 charged squares of glass, and 6,366 charged capillary tubes. Particulars as to the sources whence this lymph was derived are given in Appendix No. 1. Of the 17,929 applications in answer to which lymph was given, 15,202 came from medical practitionees (including 1,484 Poor Law medical officers) in England and Wales; 1,596 from Ireland; 545 from Scotland; 339 from the army; 148 from the navy and emigration department; 58 from colonies; and 51 from diplomatic and other foreign services.

inquiries, by correspondence or inspection, were made, with reference to local outbreaks of disease, or to nuisances which led to the fear of such outbreaks.*

Of the above proceedings only two require at present more detailed mention:—1) the administration of the Parliamentary grant for public vaccinators, and (2) the inquiry into the results hitherto obtained by local authorities in their endeavours to improve the public health.

System of gratuities to public vaccinators.

1. As regards the first of these matters, Parliament in 1866 commenced experimentally the course of subsidising public vaccination, by empowering the Lords of the Council to distribute among meritorious public vaccinators, on the principle commonly called that of "payment for results," a grant of money voted for this purpose.

The intention of this grant was not to relieve local rates of a part of the costs already chargeable on them for fees to public vaccinators, but to provide, independently of local rates, that meritorious public vaccinators should have their earnings by vaccination increased. There had always been a great deal of complaint from the medical profession that public vaccination was not sufficiently paid for. Against this complaint it was argued that guardians had no better means of determining what price to pay for public vacccination than by adopting the minimum price for which duly qualified local practitioners were willing to contract to furnish it; and that, a certain market price for vaccination being thus fixable, practitioners could not reasonably complain of terms which they had voluntarily accepted, nor guardians properly be coerced by legislation into paying an artificial, protective, price for the service. And of course on all sides it would be recognized that, however poor might be the remuneration under contract, the

* The places which were visited by inspectors, and the circumstances under which the inspections were ordered, were the following:—Leominster, Buglawton, Eydon, Warrington, and Tottenham, because of typhoid fever prevailing in them at the time, or more or less habitually;—the Medway Union, because of smallpox prevailing in it;—Llanelly, Newcastle in Emlyn, Pembroke, Narberth, Neath, and Merthyr Tydfil, because of complaints generally as to their sanitary state;—and Southwark, because of complaints as to offensive trades conducted there. The reports, or extracts from the reports, relating to Southwark, Buglawton, Warrington and Tottenham are in the Appendix Nos. 3 and 4.

In addition to the above cases, were local inspections were made, my Lords, on other occasions of local complaint or alarm, had written communications with the authorities of the following places, viz.: Cleator, Aylesford, Clapton, Workington, Bishopstoke, Oxford, Kensington, Corfe Castle, Great Harwood, Brighton, Leominster, Isleworth, Seacroft, Holbeach, Woldingham, Lees, Aspull, Gooderstone, Isle of Thanet, Rotherham, Salford, St. Blazey, Harwich, Willington, Silver Hill near Hastings, Brasted, Ropley, Tillingham, Hammersmith, Tottenham, Southover, Worthing, Kidsgrove, Chiswick, Ipswich, Cricklewood, Gilesgate Moor, Twickenham, Seaton Carew, Hornsey, West Derby Liverpool, Shirley, Bourn, Old Ford, River Lea, Hoxton, Millbank, Carshalton, Headcorn, Lyminster, Shoreditch, Shepton-Mallet, Shoreham, South Hackney, Darlaston, Marylebone, Grays, Hackney Road, Southwark, Ball's Pond, City, Blackrod, Pimlico, St. George's-in-the-East, Bedlington, Cripplegate, Newport Isle of Wight, Chester, Baldock, Greenwich, West Ham, Dodnor, Badwinter, Kilburn, Peckham, Chatham, Fulham, Beckenham, Winterton, Felixstow, St. Luke's, Dagenham, Standon, Manchester, Woolwich, Yealmpton, Belle-Isle, Bethnal Green, Minories, Wetheringsett, Corn-forth-West, New York Pateley Bridge, Wiveliscombe, Aveley, Bagillt, Cardiff.

practitioner who had voluntarily made the contract could not plead the poorness of payment as an excuse for imperfectly fulfilling his engagements. Yet, on consideration of the whole case, Parliament, in 1853, had determined that the price to be paid for public vaccination could not, with due regard to national interests, be left an entirely open question between guardians of the poor, on the one hand, and competing members of the medical profession on the other. It had fixed a minimum price of 1*s.* 6*d.* (with additional rate for distance) below which it should not be lawful for guardians to pay. But the fixing of this minimum (which in practice guardians were very apt to regard also as their maximum) did not satisfy the medical profession; and always, when consideration was being given to proposals for amending the vaccination laws, question arose whether the provisions of 1853 as to payments for public vaccination could be so changed as to remove that dissatisfaction. It was found, however, that any statutory fixing of a higher minimum rate for vaccination contracts would be strongly resisted on the part of local authorities; and apart from this kind of opposition, doubts were entertained as to the propriety of pressing any further a principle of legislation so evidently exceptional as one which aimed at protecting the medical profession from the ordinary consequences of competition among its own members. On the other hand no sensible person could avoid seeing that the national defences against smallpox might be of a most untrustworthy sort, if the business of seeing to them for each locality were virtually assigned by the guardians to the lowest professional bidder. The mischief of such a system would not lie so much in those extreme cases (which I trust would be as rare as they would be scandalous) where a contractor, poorly paid for prescribed duties, might deem himself free to neglect them: it would consist far more in the very extensive unwillingness, which would be engendered, to incur trouble beyond the letter of the contract. And this kind of feeling, as I endeavoured ten years ago to express, would, in my opinion, be the worst of dangers to public vaccination.* The national utility of public vaccination depends, to a degree which unskilled persons can hardly imagine, on the

* The following is an extract from what I wrote in 1857 on the subject:—" With respect to the present system of public vaccination in England, it remains to be remarked, that local vaccination can never be reasonably good, unless local authorities estimate the operation at its due importance. I scarcely know any surgical operation in which the result is so much determined by attention to minute particulars; scarcely any which so specially requires not to be done mechanically and *per* contract. If steam-power or clockwork were applied to the purposes of surgery, it would perhaps be as easy by machinery to amputate as to vaccinate; not because vaccination is a thing of difficult handiwork, but because peculiarly it is a thing for pains taking judgment in its details. If the local successes of vaccination are to be considerable, the public vaccinator must very often incur trouble for which there is no language in his legal contracts. Not rarely he must be content to postpone a vaccination; not very rarely he must repeat one, sometimes again and again. Always he has to watch the results and (as he is paid only for successful cases) to report them with strictness. Timing his vaccinations, so as to keep up a continuous succession, is in itself no easy task. Kindly consideration for people's feelings, often a little coaxing, sometimes a little authority, always a good deal of discretion, are—if he is to reach his utmost utility—as necessary to him as his lancet. How easily in all these particulars, and many more, might a vaccinator, bound only by his legal

condition that its local administrators shall work, not merely as competent perfunctory performers of prescribed tasks, but thoroughly with zeal for their work. And in this point of view it becomes an important public object that the scale of payment provided for their service shall be such as they can accept with satisfaction.

My Lords, after considering all the circumstances of the case, determined that the best course for them to take was to ask authority from Parliament to give to public vaccinators, under certain regulations, gratuities in excess of their contract receipts. The contract rate might, they thought, remain as heretofore, to be adjusted between guardians and medical practitioners, subject only to the actual statutory provision of a minimum; and they would assume (as indeed no other assumption is practicable) that the contract rate represents a payment which the contracting medical practitioner deems sufficient for his prescribed duties: but, inasmuch as the thoroughly well vaccinated state of the population of a place indicates, almost of necessity, that the contractor exerts himself in various ways which lie beyond the definite obligations of his contract—exerts himself with zeal both to optimise the quality, and also to maximise the quantity, of the local vaccination, therefore my Lords would ask Parliament to allow an annual sum out of which extra remuneration for this zealous work might be awarded under their Lordships' direction.

In the Vaccination Bill of last session, as amended by the Select Committee of the House of Commons to which it was referred, there was a clause which purposed to make permanent provision in the above sense. Its terms were these:—"On reports made to the Lords of Her Majesty's Council with regard to the number and quality of the vaccinations performed in the several vaccination districts of England, or any of them, the said Lords may, from time to time, out of monies provided by Parliament, and under regulations to be approved by the Lords Commissioners of Her Majesty's Treasury, authorize to be paid to any public vaccinators, in addition to the payments received by them from guardians or overseers, gratuities, not exceeding in any case the rate of one shilling for each child whom the vaccinator has successfully vaccinated during the time to which the award of the said Lords of the Council relates." The Vaccination Bill of the

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contract, escape an infinity of trouble with no ostensible fault. And unless he be fastidious in his choice of lymph, he had better not vaccinate at all; yet the difference between routine lymph and eligible lymph is to him a doubling of his labour. These are matters which can be but imperfectly known to local authorities, and which have, I daresay, seldom been considered in reference to the price to be paid for public vaccination. Boards of Guardians in making arrangements for public vaccination in their several districts have perhaps not sufficiently regarded another peculiarity of the case:—when they contract for bread and cheese, they can themselves verify the fulfilment of the bargain, and pronounce on the quality of supply: when they contract for public vaccination, they can only rely on the honour of their contractor. It is therefore, indispensable to the success of public vaccination that local authorities should duly estimate the amount of skill and conscientiousness to which they thus unreservedly trust; and that hoping to find zeal and science enlisted in their service, they should not fix their standard of payment below that which the common opinion of the medical profession would consider a reasonable and remunerating price."—Papers relating to the History and Practice of Vaccination, page lxxviii.

Select Committee could not last year become law; but before the end of the session Parliament provisionally accepted the principle of that clause, and voted a sum of 5,000*l.* to enable my Lords to carry it into effect during the remainder of the financial year.* The launching of the new scheme was necessarily delayed for some weeks by the pressure on the office of work arising out of the prevalence of cholera in England; and it is only since the end of 1866 that the intended rate of reporting for the administration of the grant has been reached. For the purposes of the inspection of public vaccination (including the purpose of administering this grant) the whole of England and Wales has been divided into four districts, each with its inspector. Two of the inspectors began from October 1st to make their recommendations as to gratuities; and a third from December 1st; but the fourth only from the first day of the present year. It is anticipated that each inspector will be able to complete the inspection of the public vaccination of his district once in every two years; and as he makes the successive steps of this inspection in the several unions or parishes of his district, he reports in succession as to the vaccinators. The adjudications of the Privy Council on these reports are monthly; and from the above-described distribution of work, each award, as a rule, will be biennial for the district to which it relates. Grants are recommended to public vaccinators whose work has been good both in quality and in quantity; and provisionally, two grades of rewardable merit have been recognised,—one to receive the whole, the other to receive two-thirds, of the sum permitted by Parliament.

On the present occasion, of course, I have only to speak of the above scheme as put in action by the Lords of the Council. On future occasions I may hope to speak of its working. And even now I will venture to express a very sanguine hope and belief that it will be found very importantly conducive to the objects for which Parliament has established it.

Works of sanitary improvement in England.

2. The inquiry of this department into the results hitherto obtained by local authorities in their endeavours to improve the public health within their jurisdiction has been among the most important and most interesting which I have had, under the Lords of the Council, to superintend. For my Lords, in their sanitary jurisdiction, can fulfil no higher usefulness than that of making new local experiences conducive to general enlightenment. And here was emphatically a case where that function required to be fulfilled. Certain of our English proceedings, specially our modern works of town-drainage with water-supply, have been great popular experiments in the management of the public health: experiments, it is true, which medical science could not deem of doubtful promise: but not the less—to the popular mind—experiments which

* While this report has been printing, the Vaccination Bill of last year has again been before Parliament, has passed both Houses without any substantial change, and (with the above-quoted provision in it) is at present awaiting the Royal assent.—Aug. 3, 1867.

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must be judged by their actual fruits. Till the sanitary experience of our best-cared-for populations had been given fully and frankly to the world, experience ripe enough for critical and conclusive judgment, the example of such populations could not be of general influence, nor could the advocates of sanitary improvement establish that their case was complete. The public, therefore, and not only our own public, but also the public of other European states, has long been anxious to possess such information as the present inquiry has aimed at. It was essential, however, that the inquiry should not be prematurely made; and it was not till two years ago that I felt myself entitled to hope that the undertaking could be free from some such reproach. In 1865 I submitted to their Lordships that the inquiry might now, in my opinion, be made with the certainty of giving valuable, though of course not final, information; and their Lordships thereupon authorized me to institute the inquiry, with the assistance of Dr. Buchanan, as inspector. In my last annual report it was adverted to as then in progress, and it has now been conducted to a conclusion. It has related to 25 towns with an aggregate population of more than 600,000 persons; and though in some of the 25 towns structural improvements have but very recently been made, in others such improvements have been in action for seven or eight years and upwards.

Anyone who would do justice to the very remarkable mass of evidence which this inquiry has elicited must study the 25 cases separately and in detail; for only thus can the circumstances be appreciated which, sometimes by exaggerating, sometimes by counteracting or concealing, particular investigated results, give more or less of exceptionality to parts of many of the cases, and render the task proportionately difficult to speak of the 25 cases as of one.

Summary Table at page 35.

Into the annexed table however (p. 35) I have abstracted those numerical results on which, when duly corrected, the broadest of our generalisations in the matter of the inquiry repose. And as an introduction to the reader's detailed study of Dr. Buchanan's report, I may here briefly draw attention to the successive columns of that table.

The column which I have headed with the letter A shows for each place in the list what difference there has been, since sanitary works have been constructed, in the *General Death-Rate* of the population. These "general" or "total" death-rates—*i.e.* rates which tell how many deaths per given population have occurred in the given time *from all causes* together and *at all ages* together, do not admit of such exact interpretation as rates in which the causes and the ages are distinguished; but of course the latter, more discriminative, death-rates tend entirely to lose their value in proportion as the distinctions which they represent have not been accurately drawn by the original recorder of facts. Registers of causes of death are (as I shall hereafter explain) very far from being uniformly trustworthy; and thus cases often arise where a comparison of general death-rates is the most instructive comparison which can be made; assuming always here that numbers of population are

known, and that ages are in like relative quantities, and that notes of important epidemic disturbances are given. Subject to these very obvious cautions, a comparison of general death-rates is a rough and ready, but fairly trustworthy, comparison of degrees of health. In this point of view I refer to column A; observing that column B gives the general death-rates of A *minus* the inconstant influence which has been exerted by the chief infantine epidemics; and similarly that column E gives means for eliminating from A the influence of the cholera-epidemics of 1848-9, 1854, and 1866.

The columns C to G inclusive are for comparing (as far as practicable) the quantities of particular kinds of death caused in each of the places in the two compared periods. Such "special death-rates," used with great caution, yield the most useful of all possible conclusions as to changes wrought in the public health: but the utmost caution in using them is indispensable, because the detailed statements which they purport to sum up are often very unequally trustworthy. The fallacies to which they are peculiarly open arise in the present and past states of our system of death certification. The law has never required that causes of death should be medically certified; and the result has been that certificates of causes of death (in varying proportions at different times and in different places) have been given by unskilled persons in such quantity, and often by skilled certifiers with so little view to statistical uses, that our most authentic (registered) information as to causes of death cannot ever be accepted without some misgiving. Further, as the quantity of non-medical certification of causes of death is probably much less now than it was (say) 20 years ago, and as likewise the discrimination and naming of diseases within the ranks of the medical profession itself has within the same time much improved, so in the annexed table any half-column which gives special deaths "after the works" may often, as compared with its fellow "before the works," represent a higher mortality than is its due; or, in other words, deaths which ought to have come within the statistics of these special columns are more likely to have gone astray in the years "before the works" than in the years "after the works." This may particularly apply to columns C and D. And I am disposed to believe that if they (especially D) were free from that source of fallacy, the evidence of the successful towns might be much more harmonious than it is.

In reading column H, the possibility has to be borne in mind that the relative quantity of infantine population in a place may have varied from time to time, and that the number of the infantine deaths in proportion to the population may in consequence have varied, independently of any variation in the local health. In Croydon, for instance, the general healthiness has been very importantly improved; but, if column H were read without the requsite interpretation, it would seem that the death-rate of infants in Croydon had increased; the fact no doubt being that Croydon, with its rapid increase of population, is having an exceptionally high

birth-rate, and that its infantine population must bear to the entire population a very much higher proportion than it bore in 1845-50.

Subject to cautions such as the above, the table will pretty well speak for itself. And of everything which seems exceptional or contradictory in it, detailed criticism, and nearly always (I think) very satisfactory explanation, will be found in the ample details of Dr. Buchanan's laborious and most accurate report. It will be useless for me here to dwell on points of this sort; but I need not refuse myself the very great satisfaction of referring to some of the splendid results which are recorded there.

Cardiff.

Foremost, I must name Cardiff. Of the monstrous mortality which that town suffered before its sanitary works were constructed, nearly a third part has now ceased. The death-rate by typhoid fever has fallen from $17\frac{1}{2}$ to $10\frac{1}{2}$; and that by diarrhœa from $17\frac{1}{4}$ to $4\frac{1}{2}$. The death-rate by cholera in 1848-9 was 208; in 1854 it was 66; in 1866 it was $15\frac{1}{2}$. The results obtained in Cardiff are the more creditable to those who have wrought them, as the difficulties to be conquered were specially great. The authorities of the place have done a great public service, and set an admirable example; not least in their choice of a medical officer, and in their confidence in him whom they have appointed. I can have few happier duties in my office than that which I now fulfil, in referring to the terms in which Dr. Paine is spoken of by Dr. Buchanan, as formerly (in my 7th report) by Dr. Hunter, and in expressing my belief that Cardiff and England are already indebted to his zeal and efficiency for the saving of many hundreds of lives.*

Newport.

In gross results Newport is at present not far below Cardiff; but, on the one hand, the task of its improvement has, I believe, been far easier; and, on the other hand, so much amendment still remains to be made in Newport, that I suspect more share of statistical accident in its present figures. If infantine epidemics (which here might cause some ambiguity) be excluded, the reduction on the former mortality is about 32 per cent. in Newport against about 35 per cent. in Cardiff. Typhoid fever and diarrhœa together have fallen from about 27 to about 17. The cholera-rate was 112 in 1848-9, and in 1866 was 12. The principal improvement in the health of the place seems to have been consequent on a better water-supply which was given about 18 years ago.

Croydon.
Macclesfield.
Salisbury.

In each of the three towns of Croydon, Macclesfield, and Salisbury, a reduction of 20 per cent. on the previous local death-

* Of the other 24 towns reported on, only four, Leicester, Newport, Merthyr, and Bristol, have given themselves the advantage of the appointment of a medical officer of health; and in Leicester alone is the appointment more than five years old. Dr. Buchanan, in these four cases, praises the exertions of the respective officers, Dr. Moore, Dr. B. Davies, Dr. Dyke, and Mr. D. Davies. In several other cases, local medical practitioners have given their fellow-townsmen valuable unpaid services, sometimes of a laborious kind, and have thus greatly promoted sanitary progress. I may specially name Drs. Westall and Carpenter, of Croydon; Mr. Rumsey, and Drs. Wright and Wilson, of Cheltenham; and Mr. Middleton, of Salisbury. Very efficient voluntary aid to sanitary progress has also been rendered in Macclesfield by Mr. May, the clerk to the board of guardians, and in Ely by Mr. Marshall, the superintendent registrar of the district.

rate has been obtained. The rates of typhoid fever and diarrhœa have diminished about as follows:—in Croydon, from 25 to $12\frac{1}{2}$; in Macclesfield, from $25\frac{1}{2}$ to $19\frac{1}{2}$; in Salisbury, from 14 to 4. The cholera rate in Salisbury was 180 in 1849; in 1854 it was $14\frac{2}{3}$; in 1866 perhaps 1.

MEDICAL OFFICER'S REPORT.

Of few places in the list is the progress, all things considered, more pleasing and hopeful than that of MERTHYR. This place used to be abominable. It had almost the unwholesomeness, with but a fraction of the apology, of Liverpool. In our statistics for 1851–61 it showed every possible evidence of sanitary neglect; in fever, in diarrhœa, in cholera, in small-pox, in phthisis and other lung-diseases, in mortality of children, test it how one would, it always was conspicuously bad; and when medical inspections were made there, every report told the same lamentable story of sanitary non-feasance to the utmost. But now improvement has fairly begun. Till 1861 its steps were at the best leisurely, but since 1861 they have been accelerated. Above all, since that date, water, which used to be cruelly scant and disgustingly foul, has been replaced by a good and ample supply. And now a system of sewers has just been completed. The results hitherto obtained—results, namely, from improved removal of nuisances, from abatement of over-crowding, and above all from the purer water supply, are, that the present mortality is a fifth less than the old; the death-rate from typhoid fever and diarrhœa has fallen from 33 to 15; and the death-rate from cholera, which in 1848 was 267, and in 1854 was 84, was in 1866 only 20. As an officer of health has now (since 1864) been appointed, and as further structural works are now coming into operation, I confidently expect and hope that a few years hence a further great reduction will have been made in the still excessive mortality of Merthyr.

Merthyr Tydfil.

BRYNMAUR, on a small scale, is a most creditable case of sanitary improvement. Paving, thorough sewerage, good water-supply, constant attention to nuisances and removal of filth, have been the means employed; and they have succeeded against some difficulties. Brynmaur saves 15 per cent. on its former general mortality. Its death-rate by typhoid fever and diarrhœa has fallen to about half what it was. Cholera, which in 1849 killed 1 per cent. of the population, has since then done no execution.

Brynmaur.

BANBURY has saved $12\frac{1}{2}$ per cent. on its former mortality, and ELY, according to two different estimates of its population, 10 or 14. In Ely typhoid fever, and in Banbury both typhoid fever and diarrhœa, are but half as fatal as they used to be.

Banbury.
Ely.

Of places where the savings have hitherto been less considerable (and in many this depends on the fact that the previous mortality was less excessive) four of the most important may be particularly noticed. DOVER has only saved 7 per cent., but this has been on a death-rate previously moderate for an unreformed town; and the improvement includes a reduction of the rate of typhoid fever and diarrhœa from $23\frac{1}{2}$ to 16. Its cholera-rate, which in 1849 had been 40, and in 1854 10, was in 1866 only $4\frac{1}{2}$. LEICESTER had and still has a high death-rate; but a dimi-

Dover.

Leicester.

Bristol.

nution, though only a small one, has been made during the few years that the works have been in action, and the fatality of typhoid fever is little more than half what it was. In BRISTOL (including Clifton) the full completion of works has been so recent that the time had certainly not come for a conclusive inquiry as to their results; and also from local reasons the statistics cannot be so expository as in most other cases; but even now there are proofs that the health of the town has been advantageously influenced by such of the works as were first in operation; and it must be remembered that in so large a town as Bristol, important absolute savings of life result from even small percental reductions of mortality. Excluding infantine epidemics, the general mortality is reduced about $4\frac{1}{2}$ per cent. Typhoid fever and diarrhœa have lost about a fifth of their fatality. The cholera death-rate was 82 in 1849, 11 in 1854, $1\frac{1}{2}$ in 1866. The general death-rate of CHELTENHAM is reduced not quite a twentieth part; but then its original rate was less than most of the reformed rates in our table; and its death-rate by typhoid fever, now $4\frac{3}{4}$, was originally only 8.

Cheltenham.

Warwick. Penrith. Stratford. Alnwick. Morpeth. Ashby.

In other places than those I have named, the reduction of typhoid fever has been generally not less than in the above cases. The death-rate, namely, has fallen in WARWICK, from 19 to 9; in PENRITH, from 10 to $4\frac{1}{2}$; in STRATFORD, from $12\frac{1}{2}$ to 4; in ALNWICK, from $13\frac{1}{2}$ to $8\frac{2}{3}$; in MORPETH, from $16\frac{1}{2}$ to 10; in ASHBY, from $13\frac{1}{3}$ to $5\frac{3}{4}$. Anyone who studies the figures of column C, and not least (with Dr. Buchanan's comments) the few exceptional facts which are represented there, will find in them a practical lesson which it is absolutely impossible to misunderstand. And scarcely less instructive is column D, though unfortunately with a larger number of exceptions; some of which, however, I suspect to be deceptive through fallacies already referred to. Column E is also one which at the present moment may be read with more than ordinary interest; showing how the power of epidemic cholera has declined, in face of the structural improvements which have been in progress.

These results, and some others which the table shows, might, I think, be most confidently anticipated; for cholera and typhoid fever, and other endemic bowel affections, are well known to stand in intimate ætiological relation to the pollution of air and soil and water with decaying excremental matters; and our statistics, unless they had been fallacious, could hardly have failed to show a diminished liability to these diseases in places where air and soil and water have been dis-polluted by sanitary administration.

Diminution of Phthisis in certain of the towns.

But in contrast with columns which only confirm previous knowledge, columns F and G, to which I have not yet adverted, record facts for which I was not in any degree prepared. These columns, namely, appear to indicate a partial dependence of PULMONARY PHTHISIS on some of the unwholesome conditions which have been removed. And when detailed examination is made of the cases which give that indication, and they are compared with the different class where phthisis has not lessened its amount, the novel and most important conclusion suggests itself, that *the drying of soil, which has in most cases accompanied the laying of main*

sewers in the improved towns, has led to the diminution, more or less considerable, of phthisis. The facts which are yet in evidence seem most strongly to support this conclusion, which, should it be substantiated, will constitute a very valuable discovery evolved by Dr. Buchanan from the inquiries here reported on. In the adjoining table, or in the table which Dr. Buchanan (p. 48) particularly gives to this matter, it will be seen that the reduction of phthisis, where certain works have been executed, is far too large and far too general to be regarded as an accidental coincidence. The reduction, namely, on the death-rates by phthisis in the first fifteen towns in Dr. Buchanan's table, are as follows:—Salisbury, 49 per cent. of its previous rate; Ely, 47 per cent.; Rugby, 43; Banbury, 41; Worthing, 36; Macclesfield, 31; Leicester, 32; Newport, 32; Cheltenham, 26; Bristol, 22; Dover 20; Warwick, 19; Croydon, 17; Cardiff, 17; Merthyr, 11. And the fact that in some of these cases the diminished fatality of phthisis is by far the largest amendment, if not the only one which has taken place in the local health, becomes extremely interesting and significant, when the circumstance is remembered that works of sewerage, by which the drying of soil is effected, must always of necessity precede, and do indeed sometimes precede by years, the accomplishment of other objects (house-drainage, abolition of cesspools, and so forth) on which the cessation of various other diseases is dependent. Thus, as regards the two largest populations concerned in this question, those of Bristol and Leicester;—no doubt the comparative smallness of effect hitherto produced on the general and diarrhœal death-rates of these towns may (so far as it is not fallacious) be referred to the shortness of time for which finished constructions have been at work for the detailed dis-pollution of houses and their dependencies; but a reduction already of a sixth in the phthisis mortality of Bristol, and a reduction of a fourth in the phthisis mortality of Leicester, are apparently connected with the fact that, in both towns, main sewerage on a large scale, with more or less drying of soil, has existed, in comparison, for many years. And Rugby which, long as it has been at work, has not yet succeeded in getting rid of endemic diarrhœa and typhoid fever, shows at least this result of its main drainage works, that its phthisis mortality has fallen 43 per cent.

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Results of the inquiry useful though not final.

Reviewing the inquiry as a whole with reference to the objects for which it was undertaken, I think I may venture to say that it has been very fairly successful. True, that the results which have been elicited are not in all cases equally intelligible, nor, of course, in all cases equally satisfactory. But, on the whole, the results are such as can be well understood by all who will somewhat carefully consider them, and such as deserve to be well pondered by the local authorities of the country. If hereafter other inquiries of the same sort are made, the investigator will doubtless have an easier task than we have now had; for the quality of the rough material of medical statistics is always in course of improvement. And also he will probably have a far simpler exposition to make; for, when the

evidence of longer periods can be collected, apparent exceptions become fewer, and the meaning of evidence far less doubtful. Meanwhile, however, the present records may fulfil very important provisional uses; not only to confute persons who have despaired, or affected to despair, of any great preventability of disease; but still more to justify in the public eye, and to encourage in some of the noblest of human labours, those who for long weary years have been spending their powers in this endeavour, and to whom surely it will be the best of rewards to see demonstration of the good they have wrought.

In conclusion I may be permitted to mention, though not strictly within the business of my present report, that the indications elicited by Dr. Buchanan as to the existence of some ætiological connexion between phthisis and local dampness of soil, have seemed to me so important that I have submitted to my Lords the expediency, in my opinion, of further inquiries in that special direction; and, as their Lordships have been pleased to direct such further inquiries to be made, I hope to be able in some future report to bring other facts into evidence on the subject.

II.—Proceedings against Cholera under the Diseases Prevention Act and otherwise.

The proceedings which the Lords of the Council took in 1866 under the extraordinary powers of the Diseases Prevention Act (including, of course, the proceedings which were preliminary to putting this Act in force) were rendered necessary by the renewed presence of Asiatic cholera in England.

A year ago, when making my report for the year 1865, I had to state that, during the period then reported on, cholera had once more become widely prevalent in Europe, and had already, though but in very small extent, shown itself in this country. As matter of anticipation it was then scarcely less than certain that the year 1866 would not come to an end without cholera having been seen here in much larger amount. And that antecedent probability has now been justified by the result. We suffered during 1866 very considerably from the disease; and even yet it would be premature to say that our share of suffering from the present fourth extension of Asiatic cholera is at an end.

Rise and progress of cholera in England in 1866.

The history of the disease in England in 1866, and of the proceedings taken by my Lords in relation to it, is, briefly, and so far as the facts came before this department, as follows.

On the 28th of April a first case was reported from Bristol, that of a trader who had arrived there sick from Rotterdam.

On May 15th telegrams from Liverpool and Birkenhead reported that the disease was prevailing on board certain vessels in the Mersey among German and Dutch emigrants, who, with a view to crossing the Atlantic for New York, had come in flocks, travelling rapidly from the continent, often from infected parts of it, by way of Hull, Grimsby, and other of our north-eastern ports, and had now fallen ill at their port of embarkation. Much alarm

was occasioned by this outbreak; the more, as new arrivals of the same sort were occurring from day to day; and my Lords, under the circumstances, thought it expedient to put the Diseases Prevention Act in force for the endangered places. An inspector (Dr. Buchanan) was also sent down to advise and assist as might be necessary; and the authorities acted with vigour and judgment. The outbreak, so far as England was concerned, soon came to an end; but the subsequent progress of the emigrants was unfortunately not unattended by cholera. Indeed, in several cases, vessels such as the above, leaving in apparent health, suffered during their voyage cholera-deaths among their passengers and crew, and were of course very dangerous arrivals for their port of destination.

Within the next few days after the 15th my Lords were apprised of the first two cases of what afterwards became a serious epidemic at Swansea; and single cases in various other parts of the country were also notified to them. Anxiety became general in the country; and there was much correspondence with local authorities, often on precautions to be taken against the disease, or provisions to be made for treating it, and often on questions of jurisdiction and responsibility.

On June 15 my Lords were informed that the Peninsular and Oriental Company's steamship "Poonah" had arrived at Southampton with a case of cholera on board, and that several other cases had appeared in the town. On the 29th two deaths were reported by telegram to have happened at Goole, whither clearly the disease had been imported from Antwerp. On the 30th three deaths were reported to have occurred at Northwich in Cheshire, and on the same day a case of cholera occurred at Shields on board the Clio, from Hamburg. On July 3d a case was reported to have happened at Harwich, on board the "Redstart," from Brussels; and on the same day, from Brixham, the death of the captain of a coasting vessel was reported.

Evidently England was now being infected in many different directions, and could hardly hope to escape a serious extension of the disease. Reports of new centres of infection became more and more frequent; and on July 14th my Lords felt that the time had come for putting the Diseases Prevention Act in force throughout the whole of England and Wales. They accordingly now issued their Order for that purpose. And henceforth ample powers of medical relief (not restricted to paupers) were exercisable by local authorities throughout the country.

On July 18th, from Poplar, the first cholera death in the metropolis was reported. Two days afterwards my Lords learnt that already there was an alarming proportion of cholera cases in parts of East London; and on the 21st the secretary of the London Hospital reported that the resources of that most useful institution were being overtasked by such claims for admission as attested a very terrible epidemic of cholera. For details as to this epidemic, and its probable cause, I may refer to a final report on it made by Mr. Radcliffe, which I subjoin, App. No. 7 f.

Hitherto the proceedings of local authorities under the Diseases Prevention Act had been discretionary; but now, with the increased dimensions of the danger, my Lords thought it their own duty to define and require, by such regulations as the Act empowers them to make, the specific services which local authorities ought to be rendering to the public. Accordingly, on the 20th and 21st of July, their Lordships issued such regulations: viz., a first set, applicable to the three unions of the City of London and to all extra-metropolitan unions and parishes, and a second set, applicable to all places within the scope of the Metropolis Local Government Act; the distinction being that in the first-named class of places the regulations had to be locally administered by the authorities of poor law relief, whereas, in the second-named class, the local authorities are the Vestries and District Boards of the not-city parts of London.* Copies of the two sets of regulations, together with an amendment which they received in their shipping clauses some weeks later (when the passing of the Sanitary Act, 1866, had first rendered such an amendment possible) are subjoined in App. No. 5. With the issue of these regulations, a memorandum which I had prepared as to their application, and generally as to precautions which ought to be taken against cholera, was published and extensively circulated; and, with this, a detailed memorandum on measures of disinfection, as well as our general memorandum on precautions against epidemic disease. Copies of these memoranda are also subjoined in App. No. 5.

The epidemic affection of England was now rapidly tending to its maximum of diffusion, and for some weeks the applications of all sorts made to the department were very numerous. The greatest number of cases of cholera in England on any one day in the year may possibly not have been reached till about the first week of September; but the greatest quantity of alarm on the subject had certainly been some weeks earlier. After the end of September the disease rapidly died away throughout the country; making

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* Section xi. of the statute, 23 & 24 Vict. c. 77., enables the Lords of the Council to vary, in certain cases, the ordinary effect of the Diseases Prevention Act as to the authorities by which the Act is to be executed. The general intention of Parliament has been (and for very obvious reasons) to vest the local administration of the Diseases Prevention Act in the hands of the ordinary administrators of Poor Law relief. But Parliament, in 1860, when reconsidering this subject, acceded to the wish of the vestries and district boards of London, that the not-city parts of the metropolis should be dealt with on a different plan, and that here the nuisance authorities, since they are advised by medical officers of health, should be the local authorities for administering the Diseases Prevention Act. It was obvious that the argument on which this exception was conceded might apply to some other places; but Parliament did not see fit to name any other exceptions to its rule. It, however, vested in the Privy Council the limited discretion to which I here refer, viz., that in places where special nuisance authorities exist in distinction from Poor Law authorities, the lords may, if they see fit, authorize such nuisance authorities to be, instead of the Poor Law authorities, the administrators of the Diseases Prevention Act. The single place in regard of which my Lords saw fit to exercise this power was Southampton; their Lordships being here strongly moved by two authorities whom the question concerned, and finding that the local circumstances were so peculiar as to justify the exceptional treatment. The general view taken by their Lordships, after careful consultation with the Poor Law Board, was that cases must be extremely rare in which the transfer would not be disadvantageous.

however, here and there, occasional small fresh outbreaks even down to the end of the year.

I am not able to say what during 1866 was the total fatality of cholera in England; but from the Registrar-General's report of the returns made to him, I learn that in the three months, July, August and September, 10,365 cholera deaths were registered, in addition to 9,570 deaths by diarrhœa. And a table (App. No. 6) which I subjoin—a sample of the weekly accounts which were compiled in this department from the returns of local officers during the epidemic, will serve to show, at least approximately, what parts of England were suffering from cholera at the time when probably this infection was the most widely diffused in the country.

Proceedings of the Privy Council as to cholera.

The proceedings which my Lords took in 1866 with reference to the general danger of cholera in England have already been stated. With reference to the particular local epidemics, my Lords proceeded almost invariably by correspondence alone. Their power of engaging medical inspectors, closely limited by circumstances as it is, would have been utterly insufficient for the crisis, if they had pretended, otherwise than in very exceptional cases, to communicate by this personal agency with local authorities. And even apart from this consideration, it was to be remembered that any too liberal employment of departmental inspectors on local service might be construed as exonerating local authorities from responsibilities which are properly theirs. The few occasions on which inspectors were employed with direct reference to outbreaks of cholera were principally in or near the metropolis. The East London epidemic was of such magnitude and concentration as peculiarly to require the vigilance of the department, and to justify any assistance which it could give to local authorities; so at various times Dr. Seaton, Dr. Buchanan and Dr. Hunter, were sent into the eastern districts, to observe the progress of the disease and the sanitary circumstances of the sufferers, or to confer with local authorities on measures of prevention and treatment; and also, at the request of the Lords of the Council, Mr. Secretary Walpole gave the department the advantage of the advice of Mr. Rawlinson and Mr. Arnold Taylor, of the Local Government Act Office, as to the state of the works of the East London Water Company. Dr. Buchanan further visited the unions of Greenwich, Deptford and Woolwich, the town of Holyhead, including the Irish Mail Steamers establishment in that place, the village of Pill, near Bristol, and, for a second time, Liverpool: in addition to which, Neston was visited by Dr. Hunter, Carnarvon by Dr. Seaton, and Southampton, as in 1865, by Professor Parkes. In my Appendix No. 7 are contained all the more important reports which reached me in relation to the above cases, including Mr. Radcliffe's report on the very elaborate research which he has made into the facts and circumstances of the great East London epidemic.

Scientific investigations of cholera.

One sort of proceeding which my Lords took in relation to cholera during the year remains yet to be mentioned. I had

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submitted to their Lordships that many pathological and medical questions, as to the nature and habits of the disease, and the principles on which it ought to be treated, were still matters of scientific uncertainty; and that, in my opinion, it was very greatly to be desired, in the interests of mankind, that, during the presence of the disease among us, methodical attempts should be made, by the researches and observations of skilled persons, to narrow, if possible, the limits of those large uncertainties. My Lords were pleased to accept this view, and afterwards to sanction a scheme, which at their desire I had submitted to them, for the organization of some such work under their auspices.

The proposed branches of inquiry were as follows:—1) examination of the degrees of success attained by different methods of *treatment* of cholera, especially as practised in the London hospitals; 2) study of the successive *chemical changes* undergone by the body in cholera, and of the relations subsisting between those changes and the symptoms which the patient presents during life; 3) similar study, chiefly microsopical, of the successive *anatomical changes* of the affected body; 4) verification of alleged experimental proofs of the *communicability of cholera;* 5) collection of facts, in the line of study opened by Professor v. Pettenkofer, of Munich, as to the non-coincidence of local epidemics of cholera with such conditions of the local ground-water as are indicated by a full state of surface-wells. For the first of these objects, four physicians of leading metropolitan hospitals—Dr. Wilks of Guy's, Dr. Martin of St. Bartholomew's, Dr. Hughlings Jackson of the London, and Dr. Bristowe of St. Thomas's, consented to act together as a committee of investigation for the Privy Council; and it was intended that, if the epidemic extended westward in the metropolis, other representative physicians should be added to their number. The second object was referred to Dr. Thudichum, as a development of the work on which he was already engaged for the department. The third, from unavoidable circumstances, remained in abeyance. The fourth was undertaken by Dr. Sanderson. And the fifth (likely in part to join on to meteorological studies) was put into the hands of Mr. Glaisher, of the Royal Observatory, Greenwich.

The results of these several studies are in part given in my appendix, but in other part are still incomplete. Happily for our endangered population, opportunities for scientific investigation of the disease neither became so general in London, nor continued for so long a time, as to enable any great programme to be fulfilled.

Towards the end of the year, Dr. Wilks, on the part of the Treatment Committee, informed me that the information before the committee was not enough to form the basis of a satisfactory report; and under these circumstance I conveyed to him their Lordships' request that the committee—since the epidemic as yet might perhaps be only suspended—would continue in function till the end of the present year. At the same time, as it seemed important to have some testimony to the quality of this epidemic (so far as yet seen) in relation to medical practice, I had their Lordships' authority

to request from Dr. Sutton, who had been in charge of Miss Sellon's temporary East London Cholera Hospital, a report on the medical experiences of that most serviceable charity; and I now subjoin (App. No. 8) the report which Dr. Sutton has in consequence written. In this context, too, I may permit myself the pleasure of referring to various interesting papers in relation to the East London epidemic which are contained as an appendix in the recent (third) volume of "Clinical Lectures and Reports by the Medical and Surgical Staff of the London Hospital," and which probably represent, as well as if they had been contributed from a wider area, the latest relations of cholera to medical treatment. Among them, in this point of view, I would particularly refer to the account which Mr. Little gives of a few cases where he tried with much thoroughness the practice of injecting, and, in case of need, re-injecting, saline fluid into the blood of persons in collapse.

The chemical investigation of cholera was pursued most laboriously by Dr. Thudichum at St. Thomas's Hospital; and I subjoin (App. No. 10) the report which he has made of the very interesting results hitherto obtained by him in that study.

That our last year's arrangements for investigation could not include the anatomy, and especially the microscopy, of the body in cholera, was matter for much regret;* the more so, as that line of study in Germany has led some of our fellow-labourers there to new and striking observations, which, under more favourable circumstances, if they had not been simultaneously made here, might at least have been verified and perhaps extended. For it is again alleged, and now as the discovery (or rather re-discovery†) of two independent German observers, Ph. Dr. Thomé of Cologne, and Professor Klob of Vienna, that the stomach and intestines of cholera patients contain within them microscopical fungic bodies, innumerable and vehemently multiplying, whereof swarms are shed, with prolific and infective power, in each characteristic evacuation of the sick.‡

The fourth branch of the inquiry was conducted by Dr. Sanderson to a satisfactory conclusion; and I subjoin (App. No. 9) his report on the subject.

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* I am glad, however, to notice that some independent study of the affected mucous membrane was made by Dr. Beale, with his eminently skilful use of the microscope, and that the results of this work have since been published by him as contributions in the Medical Times and Gazette.

† See section 5 of Boehm's classical work "die kranke Schleimhaut in der asiat. Cholera," Berlin, 1838. See also, below, App. No. 11.

‡ Dr. Thomé's observations are contained in a paper, published (with date of "end of November 1866") in Virchow's Archiv, for last February. Dr. Klob's, dated "December, 1866," are published as a pamphlet with the title "Pathologisch-anatomische Studien über das Wesen des Cholera-processes." Professor Parkes gives me the interesting information that he recognizes in the descriptions and plates of these writers the "corpuscles" or "granules" which attracted much of his attention in 1849, and are often spoken of by him (with no suspicion of their being of vegetable nature) in his paper, then published in the London Journal of Medicine, "on the intestinal discharges in Cholera;" also that he had noticed these bodies again in 1865 and 1866, when they vividly recalled the former observations to his mind; and that he noticed like bodies once in the sediment of a first cholera urine.

The fifth, under the most favourable circumstances, could not have been illustrated more than in small part during the year; but Mr. Glaisher had opened communications on the subject with observers in many different parts of the country, and I hoped to have in my Appendix a report from him on some first instalments of evidence. Unfortunately, however, about the time when he might have been reviewing his materials for such a report, serious illness (from which he is even yet not fully recovered) obliged him to suspend the inquiry.

In connexion with my account of the scientific proceedings of the department in relation to cholera, I should be glad if the time had come for stating, with any pretensions to finality, the corroborations or modifications of doctrine which, doubtless, will have to be recorded when this fourth great visitation of the disease shall have run its fatal, but most instructive course. To write now in any such sense would be premature. The studies of the disease, so far as they have gone, promise, I think, to result in considerable augmentations of knowledge; but hitherto, in my opinion, they are not so far advanced, either in this country or abroad, that I need discuss their probable bearing on previous doctrine. Instead of doing so I attach a few critical remarks to some of the papers in my Appendix. And perhaps, if circumstances should justify any further statement in questions which are now open, I may be permitted to add a postscript to this report.

Action of local authorities.

It is neither in my province nor in my power to submit any particular statement of the action taken by local authorities throughout the country in execution of the Diseases Prevention Act and of the regulations thereunder issued. It is not the practice for any local authority, except on special application, to report its action to the Privy Council; but in cases of inaction, communications are apt to be made by persons who feel themselves aggrieved; and, when I look to the comparatively small number of complaints of inaction which were made after the Order in Council, as well as to some more positive evidence in the matter, I think it may perhaps be assumed that generally the action of local authorities satisfied their constituents, and accorded in great part with the spirit (if not so much with the letter) of their Lordships' regulations.* If I may judge from the experience of London, voluntary action of all kinds was, as usual, ready to aid the autho-

* The largest exceptions to the rule were probably in regard of the regulation which provides for systematic house-to-house visitation in suffering districts, and of the regulation which enjoins the speediest possible interment of the dead. No doubt these two regulations are the most difficult of all to carry into effect; but the Diseases Prevention Act expressly provides for their being made. It is, in my opinion, desirable that local authorities should take pains to ascertain for themselves how very much real help and comfort is withheld from suffering districts when effective and systematic house-to-house visitation is not established; and also that they should better appreciate how very much alarm and horror are excited in epidemic times by any prolonged retention of dead bodies. Two or three cases of flagrant neglect of the regulation as to burials were reported to the department within a few days after the issuing of their Lordships' regulations; but in extenuation it must be admitted that local authorities, at that time, might not fully have completed their arrangements for speedy burial.

rities.* And as no place in England suffered more heavily than the Eastern districts of the metropolis, I may particularly refer to the very valuable services which were here rendered by the London Hospital, always among our foremost charities, and by Miss Sellon's temporary hospital in Whitechapel. Grateful acknowledgments are also due to the Seamen's Hospital Society, which from the middle of August voluntarily undertook the daily medical visitation of all ships in the metropolitan portion of the port of London, distributing medicines as required, and removing to the cholera ship "Belle-Isle," the cases which needed hospital treatment.

Quarantine against cholera.

I have nothing of medical importance to state with reference to proceedings taken here against cholera under the Quarantine Act. Indeed in my last report I showed the impossibility of fulfilling for England the conditions of a successful quarantine against cholera. But as I also then admitted "that quarantine, conducted with extreme rigour and with the precision of a chemical experiment, will keep cholera out of any part of Europe in which the extremely difficult conditions can be absolutely fulfilled," so it may be convenient that I now place on record two cases, brought under my notice during the year, where quarantine seems to have been effectual. A despatch to the Foreign Office, from Her Majesty's Minister at Florence, dated October 26th, 1866, gives the following statement. "The outbreak of cholera at Palermo has taken place under circumstances which merit some remark. Last year cholera prevailed at Naples, Malta, Marseilles, and other places with which the intercourse with Sicily is most frequent; but a quarantine of the most stringent, not to say exaggerated form, was enforced throughout the island, and the disease never appeared there. The same thing occurred again this summer, and notwithstanding the prevalence of cholera at Marseilles, Genoa, and Naples, it did not make its appearance in Sicily, where the quarantine was, as before, rigidly enforced. Then came the disturbances at Palermo, and the necessity of bringing troops at once from Naples, and of landing them without delay. In a few days it begun to be whispered that cases of cholera had occurred amongst them and, shortly afterwards, some of the towns-people were attacked; till, by the last returns, above a hundred deaths had taken place within the twenty-four hours." The following facts are taken from a despatch addressed on 23rd April 1866 by the Lieutenant-Governor of Dominica to the officer administering the Government of the Leeward Islands; a copy of which was received by my Lords from the Colonial Office. A brig left Marseilles in the autumn of 1865,

* During August and September numerous applications were made by local authorities to the War Office for the loan of hospital-tents and ambulances for the use of persons suffering from cholera. As "the Sanitary Act, 1866," which was passed on August 7th, gives power to metropolitan boards and vestries, and in the country to sewer authorities, to provide temporary hospitals, these applications were not indiscriminately entertained; but whenever exceptional circumstances existed (such as those of some places during hop-picking) the War Office, upon their Lordships' recommendation, granted the required accommodation, subject to the price or hire of the tents and ambulances being paid.

bound for the French island of Guadeloupe, and while she was on her voyage a boy on board died of cholera; the captain kept some of the boy's clothes, and on arriving at Pointe-a-Pitre in Guadeloupe sent them to be washed. The laundress was attacked with cholera; other cases quickly followed; and soon the disease spread throughout the island. Up to February 19th, 1866, out of a total population of 138,669, there had been 10,808 deaths from cholera registered, including no fewer than 1,934 in Basse-terre, the capital, which has but a population of 9,576; and the commander of a French ship of war which called at Dominica about the end of March informed the Lieutenant-Governor that, by that time, about one-third of the population of the capital, and about a ninth-part of the whole population of the island, had perished from cholera. Such was the magnitude of the danger which threatened the neighbouring island of Dominica, and which was, if possible, to be averted. Dominica is 22 miles from the main island of Guadeloupe, but only 15 from some of its dependencies, certain small islands called 'Marie Galante,' above-mentioned, and 'les Saintes.' Up to the beginning of November 1865, the communications between these small islands and the north end of Dominica was constant, almost daily; the markets of Marie Galante were supplied with provisions and vegetables from Dominica; and carpenters, bricklayers, and others living in Dominica, went across the narrow channel to work at Marie Galante, leaving their wives and families at home. It was on the 2nd of November that a rumour reached Dominica that cholera had broken out at Pointe-a-Pitre in Guadeloupe. On the 4th the Lieutenant-Governor of Dominica sent to the Governor of Guadeloupe for information; and feeling persuaded, after the return of the messenger, that it really was an outbreak of cholera, he on the 9th declared Pointe-a-Pitre in quarantine. Afterwards, when news arrived that the disease was spreading through the island of Guadeloupe, the whole of the island and its dependencies were placed in quarantine. Despite this precaution, a boat from Marie Galante filled with persons, some still healthy and some sick with cholera, succeeded in reaching Dominica. A street-guard was placed by the Lieutenant-Governor on the village at which these persons had landed, and for the future, 'health-guards' with loaded muskets were stationed at every place round the island where landing was possible, to prevent persons from Guadeloupe from setting foot on the island. These measures of precaution were entirely successful, and, so far as I can gather from the despatch, only two persons died of cholera in Dominica; and these were two boatmen who landed from the boat mentioned above, and died on the beach, close to the village which was subsequently isolated.

III.—The Sanitary Act, 1866.

In the year 1866 an event occurred of greatly more importance to the public health than any of these departmental proceedings which have claimed first mention in this annual report. The Legislature, namely, on the motion of my Lords, and with particular reference to

The Sanitary Act, 1866.

defects which it had been my duty to report, took into consideration the state of the sanitary law of the country, and saw fit to amend and enlarge the law by enactments of such stringency and comprehensiveness that the date of this change—the passing of the Sanitary Act, 1866, marks the beginning of a new era in the progress of sanitary reform. Fully to set forth the immense public gain which this recent legislation represents, I should have to comment on each separate section of the Act with more detail than would here be admissible; and I can only venture to advert in a few words to some of the most important of the new enactments. Such are the following:—§ 11, which provides universally for supply of water; § 19, which enlarges in several directions and with singular advantage the previous legal definition of "nuisance;" § 20, which renders it obligatory (no longer optional) for local authorities to make inspection of their districts, and, where nuisances exist, to suppress them; §§ 22-30 and 37-39, directed against various kinds of personal conduct, and various deficiencies of accommodation, which lead to the spread of contagious disease; § 35, which gives to town-authorities the invaluable power of regulating the so-called tenement-houses of the poor; not least, § 49, which creates a power of appeal to central government from the inaction of local authorities, and provides that, where sewers are not duly provided, or water not duly supplied, or nuisances not duly removed, there, in the last resort, the central government and the Court of Queen's Bench can enforce the neglected local duty. And how vastly the sphere of usefulness of local authorities is widened by the altered definition of "Nuisance" will be evident when it is observed, first, that overcrowding (certainly among the foremost sanitary evils of the country) now for the first time falls technically within that definition; and, secondly, that, under another extension of the term, the industrial millions of the country get the great boon of having all factories, workshops, and workplaces not yet under special Acts, made subject to the sanitary supervision of local authorities; and this not only in repect of uncleanliness and over-crowding, but in respect also of the often very fatal agency of "gases, vapours, dust, or other impurities generated in the course of the work." The Act, having passed only on August 7th, could not be used with much effect in relation to last year's special emergencies: its value of course was chiefly prospective; converting a law which was grievously defective into one which contains nearly all requsite provisions for the public health. For detailed evidence as to the amount of good which may be realised under the new law, I may best refer to the statements contained in my past annual reports, especially in the last five of them: on the one hand, as to the preventable diseases of the country, and the spreadings of contagious disease; on the other hand as to the influences which have been operating against human life, in the non-administration and insufficiency of the nuisance law, in the wretched house-accommodation of the poor, and, not least, in the sanitary circumstances of industry. The broad effect of this most beneficent legislation may, I believe, be summed

Water companies in relation to the public health.

up in this simple fact, that influences which have hitherto been causing about a quarter of our total mortality are now for the most part brought within control of the law.

It has seemed to me however, which I think it my duty to mention, that one important exception to this satisfactory state of the law was brought to light in connexion with last year's outbreak of cholera in London. I refer to the relations subsisting, and particularly in one respect, between commercial water companies and the public. It will be seen in Mr. Radcliffe's report that the East London Water Company, through its engineer, acknowledges to having acted in contravention of the fourth section of the Metropolis Water Act, 1852, by distributing for public use a water (and a most improper water) which had not passed through its filter-beds; and Mr. Radcliffe adduces very strong evidence to show that the East London outbreak of cholera was occasioned by this illegal and most culpable act. It seems to me that the public is hitherto very imperfectly protected against certain extreme dangers which the mal-feasance of a water-company, supplying perhaps half a million of customers, may suddenly bring upon great masses of population. Its colossal power of life and death is something for which till recently there has been no precedent in the history of the world; and such a power, in whatever hands it is vested, ought most sedulously to be guarded against abuse.

I venture to submit that the penalty of 200*l.* which the Metropolis Water Act imposes for a violation of its provisions is utterly incommensurate with the magnitude of the public danger which a lax administration of the law represents; and it is certain that in 1852, when this statute was enacted, the state of science did not yet enable the Legislature to know, as it must now know, that a water company distributing sewage-tainted water may, in a day, take hundreds of lives. In theory, no doubt, it would appear that Lord Campbell's Act (9th and 10th Vict., cap. 93) must apply to cases of this description—that actions for damages are maintainable against water-companies by the families of persons whom any wrongful act, neglect, or default of such companies has thus killed; and of course, that the person himself, if injured but not killed, can have his own action for damages. But the difficulties in taking any such course at law would, I believe, be extreme. The proof generally as to the epidemic might be complete; it might be shown to the satisfaction of a jury that the outbreak, in mass, had been caused by the distribution of a certain water, which some commercial company, with ignorant or profligate laxity, had suffered to be polluted with sewage; but, with all this clearly shown as to the epidemic generally, it might still be scarcely possible for any individual victim of the company's mal-feasance to prove (if this had to be proven) that his particular attack came from the direct operation of that and no other cause. It is probably from a perception of this difficulty that, so far as I know, no proceedings for damages have ever yet been taken against a water-company by persons whom the water has injured.

And as the deterrent influence of such personal proceedings does not operate in aid of the general law, it is, I submit, especially to be desired that any wilful or neglectful distribution of polluted water to the public should be punishable under the statute law in a very much higher degree than at present.—March 31st, 1867.

IV.—POSTSCRIPT.

Cholera Conference at Weimar.

August 3rd, 1867.—Since my above report was presented, and while it and its appendix have been printing, I have had the great advantage of comparing notes on the subject of cholera with the foremost of my fellow-workers on the Continent. Four leading epidemiologists of Germany—Professors Griesinger and Hirsch of Berlin, Wunderlich of Leipzig, and v. Pettenkofer of Munich, had proposed that an international medical conference should be held at Easter at Weimar; where persons who officially or otherwise had been much busied with the study of cholera in their respective countries might meet, from different parts of Europe, to exchange information as to past experiences of the disease, and to consult together, in the interests of the public health, both as to the best principles of defence against cholera, and also as to those prospective scientific investigations by which the knowledge of right principles might be advanced. The distinguished conveners of this meeting honored me with an invitation to attend; and my Lords, rating very highly the benefits which such conferences may give, authorized me to accept the invitation. This accordingly I did, and had the pleasure of spending several days, according to the programme, in interchanging experiences and suggestions with men whom it was an official advantage to me to consult.

Germany and England may between them claim the credit of having built up nearly all the definite knowledge which is yet possessed as to the pathology of our great modern pestilence. Each of the two countries has worked, of course, with some distinctive peculiarities of its own; and the time has now come when a thorough interfusion of the two respective stores of attainment is necessary for the progress of either country, and, therein, for the common good of mankind. I may venture to say that those whom I met at Weimar welcomed the opportunity which my presence afforded them of learning more familiarly than before the very important sanitary experiences of England, including those (not the least important of the number) which are recorded in this volume in Dr. Buchanan's and Mr. Radcliffe's reports; and on the other hand I can most strongly testify that the conference had before it, from continental and chiefly German observers, facts upon facts, of high importance and impressiveness, as to those parts of the great subject-matter which have hitherto been least cultivated in England.

As the full reports of the proceedings of the conference will shortly be published, I need not attempt any circumstantial account

Local relations of cholera to soil and its variations of state.

of the communications to which I refer, but may very briefly describe their general bearing.

First and especially, the doctrine for which Pettenkofer has long contended, that the "caprices" of cholera, as to its places and times of prevalence, have their respective roots in different qualities and different states of local soil, was illustrated by many examples. One such, as to places, was a geological map of Thuringia, with the epidemics of 1866 marked upon it; where at a glance it was seen that the epidemics in that large and varied area had been almost exclusively on one geological formation. And equally striking in the same sense were some illustrations on a smaller scale (as from Bautzen, Zwickau, Altenburg, Apolda, Würzburg, and other places) showing extremely definite boundaries of non-prevalence or minor prevalence of cholera, coincident with equally abrupt distinctions of local soil. Similarly as to the "time-caprices" of the disease, facts of considerable interest were adduced (especially from St. Petersburg, Lübeck, and Pesth) in support of Pettenkofer's view, that the different behaviour of cholera at different times in the same place is determined by temporary differences of soil: *i.e.*, by variations, in different seasons, in the thickness of superficial porous soil which is left unoccupied by "ground-water," and consequently penetrable by air: variations which in many cases can be inferred from the varying water-level of surface-wells.

Disinfection against cholera.

A next very striking set of reports related to some supposed successes, and some unquestionable non-successes, of chemical disinfection, where it had been used in the hope of preventing or arresting epidemics of cholera. I had had the pleasure of laying before the conference the very remarkable account, which Dr. William Budd of Bristol had recently published,* of the almost entire exemption of that place from cholera in 1866, under a system of disinfection which the medical officer, Mr. David Davies, to his great credit, had applied with singular assiduity and completeness. This case, taken by itself, had certainly a very hopeful complexion; but nothing could be more disheartening than some counterstatements which were made; and after them the only hope I could retain in the matter was that perhaps the good to be got from disinfection in favourable cases was not quite fully represented by the failures of Leipzig, Stettin, Erfurt, and other places in Germany. In Leipzig Professor Victor Carus, as a volunteer for his town, had been all that Mr. Davies was in Bristol; the town was divided into 100 disinfection districts, each with an officer who visited daily for disinfection with sulphate of iron every house in his district; over these district officers were four young chemists, constantly inspecting under Dr. Carus's instructions to see that all disinfection was satisfactory; and Professor Carus himself, besides superintending all this work, personally every day visited all houses which had cholera in them: disinfection had never before been tried in Leipzig, yet never had Leipzig suffered so severely from cholera. In Stettin all choleraic discharges were treated with lime and chloride of lime; but, in all the 13 cholera epidemics of the

* British Medical Journal, April 13th, 1867.

town, never had the disease been so severe. In Erfurt carbolic acid was used so lavishly that the very drinking-water reeked and tasted of it; testifying by-the-bye to a poisonous proximity of wells to cesspools; but cholera was three times more fatal there than it had ever been.

The "cholera fungus."

A third great centre of interest consisted in communications as to the so-called cholera fungus. Both Dr. Thomé and Professor Klob were present; and two of the leading mycologists of Germany, Professors Hallier of Jena, and De Bary of Halle, were associated with these gentlemen as a committee, to make in common with them a statement and appreciation of the facts which had been observed. The report, drawn by Professor De Bary, was, in substance, this: "Both observers find in cholera evacuations and in the intestinal mucus of the dead body definite organic structures, zoo-gloea, consisting of excessively fine granules, clustered more or less densely in the interspaces of a jelly, which more or less abundantly surrounds them. The granules divide and subdivide themselves, to form beaded threads, which interlace in immense numbers into felted masses in the mucus. The further development of these organisms has yet to be determined. Dr. Thomé, by sowing them, has got after some time larger round cell-like bodies, which rapidly multiplied, and also abundant filamentous fungi (*cylindro-tænium*) on which grew cylindrical spores, capable of developing again to filaments. Views as to the mutual relations of these cells, filaments and spores, are for various reasons to be expressed only with reserve, and the study of them is so immensely difficult, that definite results cannot at once be expected. The significance of these fungi would be greatly increased if they should be shown to exist in the blood as well as in the bowels of the sick: but this, though from some inquiries it seems probable, must at present be deemed questionable." To this quotation I may add that I have more recently been favoured with a letter from Professor Hallier (date June 18th) informing me that he has now himself succeeded in finding a fructifying fungus in choleraic discharges; and that by 44 different experimental cultivations he has made himself cognisant of all its forms. He mentions that it requires a high temperature (R. 25°–35°) for its fructification, and therefore cannot be of European origin.*

Present practical knowledge of cholera.

With the present opportunity of adding a few supplementary remarks to my report, and particularly with the results of the Weimar conference before me, I am led to consider once more whether the additions, which our previous knowledge of cholera has hitherto during this epidemic received, are such as to change in any respect the principles on which I have heretofore advised against cholera, or in any way to require that I should make other practical recommendations than those which were last year issued from this department, and are now subjoined in my Appendix No. 5. After giving to this question the best consideration in

* As this Report is on the point of being printed off (August 3rd) I receive Professor Hallier's finished monograph on the fungus, and shall subjoin a brief abstract of this most interesting paper. See App. No. 11.

MEDICAL OFFICER'S REPORT.

my power, I answer it, though with very mixed feelings, confidently in the negative.

Medical treatment of cholera.

Doubtless it is lamentable that one should still have to speak almost with despair of the medical treatment of developed cholera. But so it is. The task continues to be, as from our first acquaintance with the disease it has been, an almost hopeless task for the practitioner. The experience of renewed epidemics, the studies of 35 years, have in this respect done little more than warn us from various kinds of hurtful activity, and teach us that at present our utmost power is but perhaps some very little ability of palliation.* In the treatment of incipient cholera, there might certainly seem more room for hope; but competent physicians are not agreed that even here their art has much true efficiency against the disease. Practically then, more and more, as facts like the above become notorious, the business of resisting cholera on any large scale resolves itself into aims of prevention. And in contrast with the powerlessness of curative medicine, the preventive power which we possess is among the happiest possessions of science.

Prevention of cholera.

Yet here, as in the former respect, though for reasons which are widely different, I have again nothing new to advise. That which for public use in this country I believe to be, without any shadow of doubt, now as for long past years, the all-important principle of cholera-prevention: the principle that, for us, cholera derives all its epidemic destructiveness from filth, and specially from excremental uncleanliness: this of course may be iterated and re-iterated, with new and newer illustrations, but the utmost prominence which I can give to it was given in my last year's memorandum, and new knowledge neither permits me to express myself less strongly on the subject, nor enables me to express myself more strongly, than I have done even years and years ago.

The doctrine of the cholera-fungus—the alleged discovery that the specific zymosis of cholera, the bowel-fermentation in respect of which it is contagious, has essentially associated with it, and perhaps as its immediate cause, a definite multiplying organic form, is not only of the utmost philosophical interest, but, should it be substantiated, may also hereafter be found capable of very important practical application. For as one reflects on the doctrine in all its bearings, specially as one considers Professor Hallier's conjecture (based on botanical considerations) that perhaps the cylindrotænium is originally a blight of rice,† something like a clue is for the first time suggested for investigations which may hereafter

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* If among recent publications there be hinted some partial exception to the otherwise universal helplessness of medicine in cases of choleraic collapse, the exception neither in kind nor in degree is such that the ravages of the disease, in relation to masses of population, are likely ever to be much affected by it. In saying this I refer particularly to the method of saline aqueous transfusion. Not only are competent dexterity and experience wanted for this palliative treatment of collapse to have any fair chances of success, but also (with a view to immediate renewed transfusion when required) the patient has to be incessantly watched with a minute vigilance which cannot possibly be got where large numbers are concerned. See Mr. Little's paper on the subject in vol. 3 of the London Hospital Reports.

† This impressive hint is contained in a little notice which Prof. Hallier gives of his culture-experiments in No. 30 (1867) of the Berlin Centralblatt. See also App. No. 11.

conduce to the prevention of cholera in its eastern centres of origination. But for us in Europe, meanwhile, the doctrine may be absolutely sterile of results. In its broad signification, indeed, the discovery would not be a surprise to pathologists. The possibility has for some years past been recognized that perhaps every fermentatory or putrefactive change of organic material has with it, and may be as its cause, a characteristic molecular living thing;* and, however sure it may have become that the choleraic zymosis answers to that possibility, it remains yet untried whether disinfection (which after all is but a doubtful resource) can deal better with the process on that basis than on the purely chemical basis which has hitherto been the ground of our proceedings.

Relation of cholera in England to faults of drainage and water-supply.

In the long chain of cause and effect through which the rise of a certain ferment in India becomes the predestining force for subsequent outbreaks of pestilence in Europe, we see at present only one link where we may strike with the certainty of preventive effect. Whatever may be the explanation of the fact, at least empirically we know that here in Europe the pestilence rages only where there are definite sanitary evils. This knowledge remains unchanged; and unchanged remain also our practical means of applying it. Between different epidemiologists there may be differences, even strong differences, of opinion, as to the intimate nature of some of the steps by which the Asiatic influence becomes able to operate on the individual dweller in some English town; but practically all would unite in saying that the chain of evil is abruptly broken wherever thorough cleanliness prevails. The details of the contrary condition are beyond measure disgusting to write about; but more disgusting by far it would be that they should continue through not being identified. It cannot be too distinctly understood that the person who contracts cholera in this country is *ipso facto* demonstrated with almost absolute certainty to have been exposed to excremental pollution; that what gave him cholera was (mediately or immediately) cholera-contagium discharged from another's bowels; that, in short, the diffusion of cholera among us depends entirely upon the numberless filthy facilities which are let exist, and specially in our larger towns, for the fouling of earth and air and water, and thus secondarily for the infection of man, with whatever contagium may be contained in the miscellaneous outflowings of the population. Excrement-sodden earth, excrement-reeking air, excrement-tainted water, these are for us the causes of cholera. That they respectively act only in so far as the excrement is cholera-excrement, and that cholera-excrement again only acts in so far as it contains certain microscopical fungi, may be the truest of all true propositions; but whatever be their abstract truth, their separate application is impossible. Nowhere out of Laputa could there be serious thought of differentiating excremental performances into groups of diarrhœal and healthy, or of using the highest powers of the microscope to identify the

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* See in Sixth Annual Report, pp. 53-4, foot note on the experiments of Schröder and Pasteur, as to the connexion generally of fermentatory and putrefactive changes with the presence of characteristic organisms, and on the interest of these experiments to zymotic pathology.

Prevention of cholera by proper sanitary constructions.

cylindro-tænium for extermination. It is excrement, indiscriminately, which must be kept from fouling us with its decay.

And thus it is that my practical adviee remains substantially what it has been for years. The local conditions of safety are, above all, these two:—(1) that, by appropriate structural works, all the excremental produce of the population shall be so promptly and so thoroughly removed, that the inhabited place, in its air and soil, shall be absolutely without fæcal impurities; and (2) that the water-supply of the population shall be derived from such sources, and conveyed in such channels, that its contamination by excrement is impossible.

What good results are got even by rough approximation to those sanitary standards has already been abundantly shown here. The way in which the southern districts of London, with their three-fourths of a million of population, have gradually gained comparative immunity from cholera in proportion as their two water-companies have ceased to distribute sewage-tainted water among them, is matter of familiar history. And the results to which I have already referred, as found by Dr. Buchanan in various towns where works of drainage and water-supply have been provided—results which may be read at a glance in column E. of the adjoining table, are further illustrations to the same effect.

☞ See table opposite.

That cholera is still a terror to Europe shows how scantily such illustrations are yet understood. Even here in England the objects which I have named as essential are at best but rarely fulfilled; indeed for vast numbers of our population scarcely rudimentary endeavours have been made to attain them. Town after town might be named, with myriad on myriad of population, where there is little more structural arrangement for the removal of refuse than if the inhabitants were but tented there for a night. The case of the water-supply is no better: my reports are incessantly showing the too frequent foulness of private supplies; while, as regards public water-supplies, such as generally are in the hands of commercial companies, it has again and again been shown (and seldom more pointedly than in the present volume) that their conveniences and advantages are countervailed by dangers to life on a scale of gigantic magnitude, unless those who administer the supplies act under a very deep sense of responsibility.

Typhoid fever and much diarrhœa governed by same influences.

Cholera, ravaging here at long intervals, is not Nature's only retribution for our neglect in such matters as are in question. Typhoid fever and much endemic diarrhœa are, as I have often reported, incessant witnesses to the same deleterious influence; typhoid fever which annually kills some 15,000 to 20,000 of our population, and diarrhœa which kills many thousands besides. The mere quantity of this wasted life is something horrible to contemplate, and the mode in which the waste is caused is surely nothing less than shameful. It is to be hoped that, as the education of the country advances, this sort of thing will come to an end; that so much preventable death will not always be accepted as a fate; that, for a population to be thus poisoned by its own excrement, will some day be deemed ignominious and intolerable.

JOHN SIMON.

TABLE ABOVE REFERRED TO (PP. 12-17 AND 34) AS ILLUSTRATING THE IMPROVEMENTS OF PUBLIC HEALTH WHICH RESULT FROM PROPER WORKS OF DRAINAGE AND WATER-SUPPLY.

Population in 1861.	Towns in order of their Population	Periods for which the Death rates are compared.		Death-rates per annum, total and particular, per 10,000 of general Population, for each of the compared periods.																	
				A General Death rates.		B General death rates, after excluding small-pox and other infantine epidemics.		C Typhoid Fever.		D Diarrhœa, excluding Cholera so called.		E Cholera in each of the three Epidemics.			F Phthisis.		G Phthisis and other Pulmonary Diseases of Women aged 15-55.		H Death rates of Infants under one year of age.	
		Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.	1848-9.	1854.	1866.	Before the Works.	After the Works.	Before the Works.	After the Works.	Before the Works.	After the Works.
160,714	BRISTOL	1847-5	1862-51	245½	242	215	205¾	10	6½	10½	9½	82	11	1½	31	25½	16	13⅓	54	52
68,056	LEICESTER	1845-51	1862-4	264	252	236½	225⅓	14⅗	7¾	16	19⅓	1	10	–	43⅓	29¼	17¾	16	84¼	81
52,778	MERTHYR	1845-55	1862-5	332	262	292⅓	221¼	21⅓	8⅔	11½	6¼	267	84	20	38⅔	34⅓	15½	13¾	80¼	61
39,693	CHELTENHAM	1845-57	1860-5	194	185	182	172	8	4¾	8⅓	7	–	–	–	28¾	21¼	15	11¾	40½	37
32,954	CARDIFF	1847-54	1859-66	332	226	294	191½	17½	10½	17¼	4½	208	66	15½	34¾	28⅔	all ages and both sexes 66	58⅔	?	?
30,229	CROYDON	1845-50	1857-64	237	190	207	178¼	15	5½	10	7	27	21	2	?	?	all ages and both sexes 59½	49	?	?
29,417	CARLISLE	1845-53	1858-64	284	261	244	225	10	9¾	11⅓	12½	22	6	–	32	35⅖	16½	16⅔	71	65½
27,475	MACCLESFIELD	1845-52	1857-64	298	237	263⅓	217½	14¼	8½	11⅓	11	9	1	–	51½	35⅗	28⅓	22	77½	59⅔
24,756	NEWPORT	1845-49	1860-65	318	216½	275	187½	16⅓	10⅓	11	6½	112	1½	12	37	25	14	12½	67¼	53¼
23,108	DOVER	1843-53	1857-65	225½	209	203	187	14	9	9½	7	40	10	4⅔	26½	21¼	13⅓	11¼	47¾	46⅓
10,570	WARWICK	1845-55	1859-64	227	210	209¾	191⅓	19	9	5¾	8	10½	–	–	40	32⅓	16⅔	14⅔	51¼	46¾
10,238	BANBURY	1845-53	1857-64	234	205	214	184½	16	8½	11⅓	5½	2	1½	–	26⅔	15⅔	14⅔	9⅓	53	45
9,414	PENZANCE	1843-50	1856-65	221	222	197½	200⅓	7½	8	5⅓	9⅓	–	–	–	30⅔	29	13¼	14	?	?
9,030	SALISBURY	1844-52	1857-64	275	219	253⅔	198½	7½	1¾	6⅓	2⅓	180	14½	–	44⅓	22⅔	all over 20 both sexes 53½	38½	43	40
8,664	CHELMSFORD	1843-52	1855-65	196⅓	215	180	187⅓	12	12⅔	7	8	4	–	–	32⅓	32⅔	12⅔	14⅓	44	42¾
7,847	ELY	1845-52	1859-64	228	205½	210	186¼	10⅖	4½	3¾	4¼	–	22	–	31	16¾	all ages; both sexes 48	36	50⅓	42⅓
7,818	RUGBY	1845-51	1855-64	191	186	164	164½	10	9	2⅕	7½	–	–	–	28½	16¼	15	7	42½	45
7,189	PENRITH	1845-52	1856-64	253½	250	235½	230½	10	4½	3⅚	4⅚	9½	2½	–	39⅓	37½	17	19½	55⅘	55½
6,823	STRATFORD	1845-53	1860-64	217	202	212¼	178	12½	4	11¼	5¾	–	–	–	26⅔	26½	14	13	46	48
6,494	ALNWICK	1845-51	1856-64	262	247	240	221½	13½	8⅔	7	4⅔	205	–	–	28⅓	33	13½	17⅓	?	?
6,334	BRYNMAWR	1843-52	1856-65	273½	232⅓	232	209	23½	10¼	5	4¾	100	–	–	28⅓	30	14¾	13¾	76½	69
5,805	WORTHING	1843-52	1857-65	155	153	139	136½	7½	9¼	4¾	5½	–	–	–	30½	19½	14¾	9¼	24¼	22⅓
4,490	MORPETH	1845-52	1856-64	262	247	234	225	16½	10	8½	14½	14	11½	–	30½	28	14	14⅔	56	57½
3,840	ASHBY	1845-51	1855-64	216	202½	213	184	13⅓	5¾	4	8⅓				25½	31⅓	16	13	48	31

APPENDIX.

No. 1.—STATISTICS OF THE NATIONAL VACCINE ESTABLISHMENT.

1. STAFF of the ESTABLISHMENT at end of 1866.

N.B.—The Stations named in *italics* are Educational Vaccinating Stations, authorized by the Lords of the Privy Council, for the purposes of their Lordships' Order of December 1, 1859.

	Members of the National Vaccine Establishment supplying Lymph for the Public Service.	Vaccinating Stations.	Days and Hours of Attendance.
Vaccinators salaried from the Parliamentary Grant.	Mr. John Newton Tomkins, Inspector.	Fitzroy Street.	Mon., Tues., Wed., Thur., Fri., Sat.; 10—11.
	Mr. James Furness Marson.	*Surrey Chapel, Blackfriars Road.*	Tuesday, Thursday; 1—2.
	Mr. George Lewis Cooper.	Battle Bridge.	Tuesday; 12—1.
	Dr. Richard Sharpe -	Bermondsey.	Tuesday; 10—11.
	Mr. Robert Wade -	Dean Street, Soho.	Monday; 12—1.
	Mr. Arthur Bernard Macann.	King Street, Portman Square.	Monday; 10—11.
	Mr. Wm. Jones Lewis.	Spital Square, *Wellclose Square.*	Monday; 10—11. Tuesday; 9—11.
	Mr. George Simpson	*Tottenham Court Chapel.*	Monday, Wednesday; 1—2.
Parochial and other Vaccinators not salaried from the Parliamentary Grant, but furnishing Lymph at a fixed rate of payment.	Mr. Ellis Southern Guest.	*Manchester.*	Monday; 2—4.
	Mr. John Garner -	*Birmingham.*	Monday; 10—12.
	Mr. William Yeoman Sheppard.	*Bristol.*	Tuesday; 10—12.
	Mr. Arthur Browne Steele - - Mr. John Henry Wilson - - Mr. John Fenton -	*Liverpool.*	Monday; 9—10. Friday; 2—3.
	Dr. Edward Lowe Webb.	*Pimlico.*	Monday; 10—12.
	Mr. James Lunn Gilchrist.*	*Newcastle-on-Tyne.*	Tuesday; 2—3.
	Mr. William E. Grindley Pearse -	*Westminster.*	Monday; 9—11.
	Mr. James George Gerrans.	*Marylebone.*	Monday; 10—11.
	Mr. Robert Cottam†	*Leeds.*	Tuesday; 2—3.
	Dr. Edward Lynes -	Coventry.	Monday; 12—2.
	Mr. Joseph Teale -	Salford.	Thursday; 3—4.
	Dr. James Dunlop -	*Glasgow.*	Monday; 12—1.

* Since deceased, and replaced in the above capacity by Mr. George Cuthbert Gilchrist.

† Since deceased, and replaced in the above capacity by Mr. Frederick Holmes.

Appendix.

No. 1.
Statistics of the National Vaccine Establishment.

Statistics of the National Vaccine Establishment—*continued.*

2. Sources and Amount of Lymph Supply in 1866.

N.B.—The Stations named in *italics* are Educational Vaccinating Stations, authorized by the Lords of the Privy Council, for the Purposes of their Lordships' Order of December 1, 1859.

	Vaccinating Stations.	No. of Vaccinations performed at the Stations respectively. Prim^y	Re-vac^ns	No. of charges of Lymph supplied from the Stations respectively.	Remarks.
Vaccinators salaried from the Parliamentary Grant.	1. Fitzroy Street. - -	466	—	4,750	
	2. *Surrey Chapel* - - -	994	41	15,000	
	3. Battle Bridge - -	444	—	8,178	
	4. Bermondsey - -	462	25	5,183	
	5. Dean Street, Soho - -	467	56	15,910	
	6. King Street, Portman Square	271	14	6,077	
	7. Spital Square - -	310	2	11,305	
	8. *Wellclose Square* - -	271	2	9,304	
	9. *Tottenham Court Chapel* -	1,659	42	13,550	
Total -	9 Stations - - -	5,344	182	89,257	
Parochial and other Vaccinators not salaried from the Parliamentary Grant, but furnishing Lymph at a fixed rate of payment.	1. *Manchester* - - -	1,323	4	19,558	
	2. *Birmingham* - - -	1,138	6	4,549	
	3. *Bristol* - - - -	307	—	1,000	
	4. *Liverpool* - - -	738	—	16,822	
	5. *Pimlico* - - -	637	14	14,731	
	6. *Newcastle-on-Tyne* - -	403	3	13,514	
	7. *Westminster* - - -	709	54	13,172	
	8. *Marylebone* - -	852	103	8,148	
	9. *Leeds* - - -	497	—	12,038	
	10. Coventry - - -	563	—	1,662	
	11. Salford - - -	806	—	6,540	
	12. *Glasgow* - - -	630	6	6,023	
Total -	13 Stations decreased during the year to 12 - -	8,603	190	117,757	
General Total	22 Stations decreased during the year to 21 - -	13,947	372	207,014	

Statistics of the National Vaccine Establishment—*continued.*

APPENDIX.

No. 1.
Statistics of the National Vaccine Establishment.

3. SUMMARY for the Years 1856–1866.

Year.	Total Vaccinations performed.	Re-vaccinations included in preceding Column.	Number of Charges of Lymph supplied.
1856 - -	7,039	?	210,942
1857 - -	6,327	?	213,207
1858 - -	6,445	?	234,150
1859 - -	9,030	?	237,801
1860 - -	13,849	?	228,347
1861 - -	12,009	?	225,000
1862 - -	13,149	?	211,475
1863 - -	20,600	?	239,432
1864 - -	13,727	?	203,250
1865 - -	14,648	515	219,832
1866 - -	14,319	372	207,014

APPENDIX.

No. 2.
On Results of Works, &c., for promoting Public Health, by Dr. Buchanan.

SUMMARY REPORT.

No. 2.—REPORT BY DR. BUCHANAN ON THE RESULTS WHICH HAVE HITHERTO BEEN GAINED IN VARIOUS PARTS OF ENGLAND BY WORKS AND REGULATIONS DESIGNED TO PROMOTE THE PUBLIC HEALTH.

General Conclusions and Inferences.

1. Twenty-five towns have been visited in the course of 1865–66, in which the authorities have carried out works designed for the improvement of public health. These towns were chosen, after consultation with the Local Government Act Office, as being places where structural sanitary works had been most thoroughly done, and had been longest in operation, and were not chosen for any previously ascertained improvement in their health. They are believed to represent a considerable majority of the towns of England that are available for the purposes of the inquiry.

Towns visited. Their population.

2. The 25 towns contain an aggregate population of 606,186 persons according to the census of 1861, and range in size from small places of 3,000 or 4,000 inhabitants, to Bristol-with-Clifton, which had 160,714 inhabitants at the last census.

Method of inquiry.

3. For these towns the mortality statistics of the past 20 years—and for some, of a rather longer period—have been very carefully investigated, with attention to every point that would add to the trustworthiness of deductions from them.* On the aggregate, upwards of 300,000 deaths have been taken into consideration ; in most towns the actual registers having been analysed. Comparison has then been made between the mortality before the execution of the sanitary works and the mortality while they were in progress and after their completion ; and reference has been had to particular ages and to particular diseases as well as to totals of deaths. Alteration in the public health of the towns occurring since the sanitary works has been judged of, almost exclusively, by these mortality statistics, a method in which there are certain confessed weaknesses, but which had necessarily to be employed, inasmuch as there existed no other available source of information at

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Precautions.

* 1. The population of towns visited has been calculated for each year (by the formulæ in use at the General Register Office) on the data supplied by the censuses of 1841, 1851, 1861. But where there has been reason to believe that the population has fluctuated irregularly between the censuses, the best local estimates of the nature and amount of that fluctuation have also been considered. Wherever uncertainty existed, and a choice had to be made between two estimates of population, the principle (which has been acted on throughout the inquiry) was adopted, of taking that estimate which might understate, and not the estimate which might exaggerate the degree of change in death-rates. 2. Correction has, in every important instance, been made for the deaths of persons who had no previous residence in a district, but who had been brought into its workhouse or hospital shortly before their death ; and conversely, as far as possible, for the deaths of persons removed from a district and dying in outside workhouses or hospitals. 3. Respecting the names of diseases, it was necessary to employ considerable discretion in analyzing death registers. When two causes of death were stated, the more important one was of course taken, *e.g.*, Convulsions, bronchitis," was entered under *lung disease :* but "teething, convulsions" was set down under the *brain diseases* of infancy ; with the caution, reiterated in the accounts of the several towns, that no great importance attaches to the so-called cause. But it was further necessary to take some liberties with the registered nomenclature. It will not be disputed that "Sloughing tonsils, croup," is better entered under *diphtheria* than under *croup ;* that "Fever, albuminuria" occurring in a child during a scarlatina epidemic, is better taken as *scarlatina* than as *continued fever ;* and that the presumption about such entries as "Bronchitis, enteritis, melæna" or "Diarrhœa, three weeks, Peritonitis, two days" in young adult males, is that they were cases of *typhoid fever.* Similarly leave has been taken to omit from the column of *fever* chi dren "*aged two days*" entered in the register as dying of that complaint ; "enteritis" in infants has been put down to *diarrhœa ;* "hæmoptysis" in young adults to *phthisis*, and so forth. The discretion that has been assumed would perhaps not have been needed if the scheme of the inquiry had been to show the cause of every death, but it is plainly essential where registers are examined in respect of certain diseases only.

all approaching to the mortality statistics in completeness and accuracy. The experience of medical men and other local sanitarians was, however, constantly appealed to for correction or corroboration of deductions drawn from the death returns.*

Nature of sanitary works.

4. The nature of the sanitary operations carried out in these 25 towns has been various, and they have been variously combined. They have usually consisted of some or all of the following :—A. Of drainage works affecting (1) surface, (2) subsoil, or (3) houses.—B. Of improvements in water supply, (1) amending or extending previous sources of supply, or (2) adding or substituting new sources.—C. Of measures designed for the removal of decomposing organic matters, or for preventing contamination of air and water thereby, and which more or less completely fulfilled these objects, viz., (1) the substitution of a watercloset system for cesspools and middens, or (2) the drainage and improving of middens.—D. Of improved paving, scavenging, and public cleanliness. And E. Of amendment of the lodgment of the inhabitants, the regulation of common lodging-houses, and the repression of overcrowding.

Change in total mortality.

5. The change in *total mortality* observed in these towns, when the period before their sanitary works is compared with that after the completion of them, is as follows, the towns being arranged in the order of their rates of diminution :

See page	Town.	Population 1861.	Change in Death-Rate per 10,000.	Reduction on earlier death-rate (*see* Note).
92	Cardiff - -	32,954	From 332 to 226	32 p.c. or, omitting cholera, 24 p.c.
121	Newport (Mon.) -	24,756	„ 318 „ 216	32 p.c. or, omitting cholera and dysentery, 23 p.c.
98	Croydon - -	30,229	„ 237 „ 190	20 p.c. or, omitting cholera, 18½ p.c.
113	Macclesfield - -	27,475	„ 298 „ 237	20 p.c.
150	Salisbury - -	9,030	„ 275 „ 219	20 p.c. or, omitting cholera, 9 p.c.
79	Merthyr - -	52,778	„ 332 „ 262	18 p.c. or, omitting cholera, 13 p.c.
188	Brynmawr - -	6,334	„ 273 „ 232	15 p.c. or, omitting cholera, 11 p.c.
161	Ely - - -	7,847	„ 239 „ 205½	14 p.c.
141	Banbury - -	10,238	„ 234 „ 205	12½ p.c.
203	Ashby-de-la-Zouch	3,840	„ 216 „ 202½	9 p.c.
105	Carlisle - -	39,417	„ 284 „ 261	8 p.c. or, omitting cholera, 7 p.c.
135	Warwick - -	10,570	„ 227 „ 210	7½ p.c.
129	Dover - -	23,108	„ 225½ „ 209	7 p.c. or, omitting cholera, 6 p.c.
177	Stratford-on-Avon -	6,823	„ 217 „ 202	7 p.c.
198	Morpeth - -	4,490	„ 262 „ 247	6 p.c. or, omitting cholera, 5 p.c.
182	Alnwick - -	6,494	„ 262 „ 247	6 p.c. or, omitting cholera, increase of 6 p.c.
70	Leicester - -	68,056	„ 264 „ 252	4½ p.c.
86	Cheltenham - -	39,693	„ 194 „ 185	4½ p.c.
167	Rugby - -	7,818	„ 191 „ 186	2½ p.c.
58	Bristol with Clifton	160,714	„ 245½ „ 242	1½ p.c. True reduction greater.
172	Penrith - -	7,189	„ 253½ „ 250	Nil.
193	Worthing - -	5,805	„ 155 „ 153	Nil.
145	Penzance - -	9,414	„ 221 „ 222	Nil.
—	Ottery St. Mary† -	2429	—— ——	Probably stationary.
155	Chelmsford - -	8,664	„ 196⅓ „ 215	Increase.

NOTES.—The reduction in several of these towns is greater than it otherwise would be by reason of the cholera in 1849 swelling the mortality of the period before sanitary work. As it is well to exhibit the reduction apart from this great cause of disturbance, the degree of reduction after omission of cholera, is also shown for the towns notably affected. Epidemic dysentery in Irish immigrants has been also deducted as a correction for Newport. But no allowance in these totals is made for Irish typhus. In Ely there is some question as to population that makes the exact death-rate of earlier periods doubtful. Bristol with Clifton would certainly show better progress if it had been possible to take the mortality statistics of the precise area submitted to sanitary improvement. In Penzance, sanitary works are only just completed.

† For Ottery only some general conclusions can be drawn, as the manner in which the registers were kept rendered it impossible to get accurate statistics for this interesting little place. No detailed account of the condition of Ottery will appear in this report, but the broad facts concerning it are stated in the "general scheme" which follows.

* For facilities in the conduct of a large and intricate inquiry, very cordial acknowledgment is due to the Registrar General, not only for access to the records of his office but for much active assistance ; and to the officers of local boards of health, medical practitioners, local registrars, and others, who have put their time and knowledge freely at disposal, and entered with much interest into the objects of the inquiry.

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6. In the great majority of the 25 towns there has been distinct reduction of the total death rate. In nine of them having an aggregate population of 204,641, this reduction has amounted to about a fifth part of the previous rate of death. In 11 other towns the fall in the death rate has been less considerable. In three or four towns (including one that has scarcely finished its works) the rate has been stationary, and one shows an increase in the rate of mortality since the period when the works designed for its improvement were executed.

Reduction of total mortality.

Some causes of differences among towns.

7. Some of the reasons for the position of towns on the above list readily occur. Thus at the head of the list, with chief reduction of mortality, are towns where the previous death rate was most excessive, as in Cardiff, Newport, Merthyr, where it had exceeded 300 in the 10,000 yearly ; and, secondly, towns where, along with sanitary improvement, notable change in the social or industrial conditions of the population has taken place ; of this, the chief examples are Croydon and Macclesfield. At the other end of the list appear towns that cannot yet have got the full fruit of their sanitary work, as Bristol and Penzance, or that had previously a death rate close upon the necessary annual rate, as Cheltenham, Rugby, Worthing, and Chelmsford. These considerations require to be plainly kept in view if a judgment of the relative value of sanitary measures in various towns is to be obtained.

Change in mortality from particular causes.

8. The inquiry has next been concerned with the nature of the diseases, the subsidence of which has brought about the general reduction of mortality, and with the character of the special sanitary operations that may have so far coincided with fluctuations in disease as to deserve recognition as the causes of those fluctuations. More particular examination has been made (1) of the deaths of children under one year of age ; (2) of the diseases that are chiefly apt to prevail epidemically ; (3) of consumption, lung and brain diseases. Avoiding in this summary report, as far as possible, all statements that are merely negative respecting these and other points investigated, the following results have been arrived at.

Infantile mortality.

9. Respecting the mortality of *infants under one year of age*, there is no profit in separating the registered causes of death. It is obvious that deaths which in one town or in one period are set down to "atrophy" are in another largely ascribed to "convulsions," and in a third to "teething." Taken together from all causes, the deaths of infants have been reduced in the several towns very much as the total mortality at all ages has been ; the reduction having been greatest where the previous mortality among infants was excessive. Thus at Merthyr, for every 100 infants who died before sanitary influences came into action, 76 only have since died. In Cardiff for that 100 only 78 have since died ; in Macclesfield 77. In Newport their mortality has not so much subsided. In Croydon, where the altered circumstances of the town have brought about a largely increased birth rate, more deaths of children, in proportion to total population, have been registered in late years than formerly, although the general mortality has so notably decreased.* Of special influence, either in amount or kind, exerted by sanitary works upon children under one year of age, different from that exerted upon the total population, no evidence whatever has been obtained.

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* If it had been possible to calculate the death-rate of infants on the numbers of infants living in the town at various periods, this would have been done; as it is, the death-rate of infants is calculated on the total population.

10. All the class of *contagious diseases* has been carefully investigated, but two of its members cannot profitably be considered here: *small-pox* having been variously influenced by another set of conditions whose effect cannot be eliminated; and *typhus fever* having scarcely occurred in any of the towns except at the wholly anomalous epidemic of 1847–8. With regard to others of these contagious diseases, great caution is needed in coming to any present conclusion. For it is not by single years that the intensity of these diseases can be measured, nor even by comparing one cycle of their prevalence with another, but by taking several such cycles both before and after the operation of the sanitary works the influence of which it is wished to ascertain. The time has not yet arrived for forming an accurate estimate of the effect of works of sewerage, water supply and the like upon measles, scarlatina, and whooping-cough, inasmuch as epidemics of these diseases may revolve in long periods; and the following inferences must be taken, subject to correction by longer experience.

Class of contagious diseases.

11. *Measles* has appeared, with a good deal of approach to constancy, to undergo reduction in those towns where the sanitary works have removed to a pretty complete extent serious pre-existing organic impurity of air. In the towns where there was most room for improvement in this respect, and where most improvement has been actually made, measles has commonly been reduced; and the towns where it has remained stationary or has increased in amount, are those which either had less foulness of atmosphere to begin with, or have made less radical improvement of it. But there are several exceptions to this general statement. The introduction of better drinking water has not perceptibly affected the prevalence of measles, but some connexion appears probable between reduction of measles and diminished density of population.

Measles.

12. Of *whooping-cough* nothing can be said as to the effect of any sanitary measure on it for good or bad; only with it, as with measles, there appears to be some approach to regularity in the way it has declined most where the lodgment of the people has been improved. Of *scarlatina*, after careful analysis of every condition, absolutely nothing can be observed coincident with the rise and fall of this disease in various towns; though if South Wales be excluded, which has latterly been swept by a scarlatina epidemic that no sanitary influence has been able to resist, there does appear some probable connexion between reduced prevalence of scarlatina and diminished crowding in houses.

Whooping cough and scarlatina.

13. Deaths from *croup* and *diphtheria* have, in almost every town, increased in frequency of recent years, and this has happened either during or after the completion of their sanitary works. Certain of the places visited have suffered considerably from diphtheria. On several South Wales registers it is doubtless this disease that appears as an epidemic of croup at least as early as 1849, and which is recognized by its own name in 1851. In Newport the disease certainly declined after works of sewerage and cleansing were completed. But in the great majority of towns diphtheria did not exist so early as here. Chelmsford has been the greatest sufferer from diphtheria, which in 1858-62 was fatal to 65 per 10,000 of its population. Dover stands next in its amount, doubtless through peculiar exposure to continental sources of infection. In both these towns diphtheria only appeared after works of drainage and water supply were completed.

Croup and diphtheria.

14. *Typhoid fever* has been separated pretty satisfactorily from typhus for those towns where typhus has prevailed, and the death rate caused by typhoid—the ordinary endemic "fever" of country towns—has been

Typhoid fever.

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Reduction of typhoid.

calculated for itself. Thus examined there is found the following extent of reduction from the previously existing death-rate of this disease :—

See page		Town.	Change in typhoid death-rate per 10,000 annually.	Degree of change.
150	Reduction exceeding half.	Salisbury - - - -	From $7\frac{1}{2}$ to $1\frac{3}{4}$	−75 p.c.
177		Stratford - - - -	„ $12\frac{1}{2}$ „ 4	−67 „
98		Croydon - - - -	„ 15 „ $5\frac{1}{2}$	−63 „
79		Merthyr - - - -	„ $21\frac{1}{3}$ „ $8\frac{2}{3}$	−60 „
161		Ely, - - - -	„ $10\frac{2}{3}$ „ $4\frac{1}{2}$	−56 „
203		Ashby - - - -	„ $13\frac{1}{3}$ „ $5\frac{3}{4}$	−56 „
188		Brynmawr - - -	„ $23\frac{1}{2}$ „ $10\frac{1}{4}$	−56 „
172		Penrith - - - -	„ 10 „ $4\frac{1}{2}$	−55 „
135		Warwick - - -	„ 19 „ 9	−52 „
70	Reduction between one-third and one-half.	Leicester - - -	From $14\frac{2}{3}$ to $7\frac{3}{4}$	−48 „
113		Macclesfield - - -	„ $14\frac{1}{4}$ „ $8\frac{1}{2}$	−48 „
141		Banbury - - -	„ 16 „ $8\frac{1}{2}$	−48 „
198		Morpeth - - - -	„ $16\frac{1}{2}$ „ 10	−40 „
92		Cardiff - - - -	„ $17\frac{1}{2}$ „ $10\frac{1}{2}$	−40 „
86		Cheltenham - - -	„ $7\frac{1}{3}$ „ $4\frac{2}{3}$	−37 „
121		Newport - - - -	„ $16\frac{1}{3}$ „ $10\frac{1}{3}$	−36 „
129		Dover - - - -	„ 14 „ 9	−36 „
182		Alnwick - - - -	„ $13\frac{1}{2}$ „ $8\frac{2}{3}$	−36 „
58		Bristol - - - -	„ $9\frac{2}{3}$ „ $6\frac{1}{2}$	−33 „
167	Trivial reduction.	Rugby - - - -	From 10 to 9	−10 „
105		Carlisle - - - -	„ 10 „ $9\frac{3}{4}$	− 2 „
155	More or less increase.	Chelmsford - - -	From 12 to $12\frac{2}{3}$	+ 5 „
145		Penzance - - -	„ $7\frac{1}{2}$ „ 8	+ 6 „
193		Worthing - - -	„ $7\frac{1}{2}$ „ $9\frac{1}{4}$	+23 „

Coincident improvements in water, cleansing, &c.

Many of the public improvements have coincided with reduction of typhoid. Though not with absolute constancy, drying of the soil of a town and reduction in the crowding of houses have been followed by reduction of fever. Much more important appears to be the substitution of an ample supply of good water for a scanty and impure supply : other things being equal, the towns in which this substitution has been completed have made most improvement. Merthyr is a conspicuous instance of a town where before any other important change had been made, typhoid fell to a notable extent as soon as inspection and cleansing were adopted.

In purification of air.

It is however, the purification of atmosphere from decomposing organic matters, that has been most uniformly followed by a fall in the prevalence of typhoid. And this has occurred equally whether the purification has been brought about by the abolition of cesspools or by draining and drying "middens." Apparent exceptions, indeed, are found in certain towns at the bottom of the foregoing list (disregarding Penzance, where the drainage works have just got into operation), viz :—Rugby and Carlisle where the reduction has been of slight amount, and Chelmsford and Worthing where there has been more or less increase of fever. But in these four towns and in no others (for Leicester* need not

* Leicester, it is true, also discharges its sewage into a pumping tank, but Leicester is provided with a second system of storm sewers, between which and the pipes there are communications which cause the physical condition of the sewers to differ in this

be considered) sewage is received into pumping works at the outfall, in such a way that sewer gases are necessarily much confined in the pipes. In the case of Worthing the defect of the outfall arrangement was most serious, and in the absence of other exits, sewer gases had demonstrably been forced into houses and outbreaks of typhoid had occurred as the demonstrable result thereof. In the other towns, though to an inferior degree, there were facilities for the same accident occurring. So that it appears that the four towns where fever has not been greatly reduced, are so far from constituting an exception to the rule—that removal of organic impurity from the air has been followed by reduction of typhoid—that they even add strongly to the presumption that the rule is absolute and universal.*

town from the other four named. Still, it is worth noting that Leicester goes with the other four in its increase of diarrhœa death rate.

Maintenance of typhoid in certain towns.

* On Worthing the following report has been made respecting a notable outbreak of fever in 1865 :—

" At the outfall works the sewage enters a tank at 20 feet below the surface, and is lifted by engine power into a delivery box above the surface, from whence it is discharged by gravitation. Everything has depended on the pumping power of the engine. When it is not at work sewage accumulates in the well. When the sewage is delivered in excessive amount beyond the utmost capabilities of the engine, there has been no outlet for it, but it has filled the well and backed up the sewers. In prolonged wet weather, consequently, it has happened that water (more or less charged with sewage) has regurgitated into the basements of certain houses. In such a conjuncture, means of relieving the sewers from the pressure of gases within them become of the greatest importance; and from the absence of such means in Worthing it has resulted that often in a wet season waterclosets smell universally, and gas has been known to be forced up through their traps. Now, in 1865, the difficulties inherent in the existing arrangements were developed through peculiarities in the seasons. To begin with, during the hot weather of the early summer of that year the drains were very ill flushed, partly through a scantiness of available water supply, caused by the waste of it, partly, it is suggested, through the neglect of a former surveyor. Then came an extremely wet autumn ; the sewage in the well could not be kept down to its proper level, it backed up the sewers, flooding certain basements. Now the especial want of ventilating openings to the sewers appeared. Foul gases generated in the previous time of drought had no means of escape but by bubbling up through the traps of sinks and waterclosets. This was heard to occur in some houses where waterclosets were inside. The probability that this condition of things was the cause of the typhoid fever which broke out in the autumn of 1865 (the chief outbreak and the only one investigated by the Council), appears to reach positive demonstration when it is added that the fever almost exclusively attacked well-to-do houses on the higher levels, where the waterclosets were inside the houses, and almost entirely spared the houses, mostly of a much poorer sort, situated on lower levels, where the closet was placed outside the house. It was not so in the times of cesspools ; then these lowlying poor houses were far more attacked with fever than the others. Moreover, the fever subsided as soon as openings were made into the sewers from certain houses, where it had before maintained itself for months."

In Chelmsford, again, there has been no decrease of typhoid fever. Here, too, the sewage is delivered into a tank by an outfall sewer, which enters some 6 feet below ground. The opening can be covered by a sluice, or it may get covered by the rise of sewage in the well when the engine is not at work, or the quantity of liquid is in excess of its pumping power. There is, indeed, a storm overflow into the river to prevent the sewage backing up beyond a certain point, but it is a fact that in certain conjunctures cellars do occasionally get flooded by the sewage in spite of this overflow, and still more must there then be a tendency of sewer gas to escape from the pipes ; and though this is provided for by some downspouts being left untrapped, it is at critical times left for a very easily occurring stoppage in a rainwater pipe to determine whether or not sewer gases shall be forced up through the inch or two of water that is provided to exclude them in the ordinary sink and closet.

At Carlisle and Rugby the arrangements at the outfall tank were not such as to permit of sewage being backed up to the same extent as at Worthing and Chelmsford and in Carlisle and Rugby provision is made for the ventilation of sewers. Moreover at Carlisle there is some doubt about the quality of water.

The constructive differences between themselves in the four towns that pump their

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Diarrhœa.

Extent of change.

15. *Diarrhœa* is another disease which appears to have been reduced by purification of air and water. Removal of subsoil water has not at all, and alteration in the lodgment of people has not materially coincided with fluctuations in its amount.

The changes in this disease have been as follows:—

See page	Town.	Change in diarrhœa death rate per 10,000 annually.	Degree of change.
92	Cardiff* - - - -	From $17\frac{1}{4}$ to $4\frac{1}{2}$	− 75 p.c.
150	Salisbury - - - -	„ $6\frac{1}{3}$ „ $2\frac{2}{3}$	− 60 p.c.
177	Stratford - - - -	„ $11\frac{1}{4}$ „ $5\frac{3}{4}$	− 50 p.c.
79	Merthyr - - - -	„ $11\frac{1}{2}$ „ $6\frac{1}{4}$	− 45 p.c.
141	Banbury - - - -	„ $11\frac{1}{3}$ „ $5\frac{1}{2}$	− 45 p.c.
121	Newport - - - -	„ 11 „ $6\frac{1}{2}$	− 40 p.c.
182	Alnwick - - - -	„ 7 „ $4\frac{2}{3}$	− 33 p.c.
98	Croydon - - - -	„ 10 „ 7	− 30 p.c.
129	Dover - - - -	„ $9\frac{1}{2}$ „ 7	− 26 p.c.
86	Cheltenham - - -	„ $8\frac{1}{3}$ „ 7	− 16 p.c.
188	Brynmawr - - -	„ 5 „ $4\frac{3}{4}$	− 5 p.c.
113	Macclesfield - - -	„ $11\frac{1}{3}$ „ 11	− 3 p.c.
161	Ely - - - -	„ 4 „ $4\frac{1}{4}$	+ 7 p.c.
105	Carlisle - - - -	„ $11\frac{1}{3}$ „ $12\frac{1}{2}$	+ 10 p.c.
155	Chelmsford - - -	„ 7 „ 8	+ 14 p.c.
193	Worthing - - -	„ $4\frac{3}{4}$ „ $5\frac{1}{2}$	+ 16 p.c.
70	Leicester - - -	„ 16 „ $19\frac{1}{3}$	+ 20 p.c.
172	Penrith - - - -	„ 4 „ 5	+ 25 p.c.
58	Bristol - - - -	„ $6\frac{3}{4}$ „ $9\frac{1}{2}$	+ 40 p.c.
135	Warwick - - -	„ $5\frac{3}{4}$ „ 8	+ 40 p.c.
198	Morpeth - - -	„ $8\frac{1}{2}$ „ $14\frac{1}{2}$	+ 70 p.c.
145	Penzance - - -	„ $5\frac{1}{3}$ „ $9\frac{1}{3}$	+ 75 p.c.
203	Ashby - - - -	„ 4 „ $8\frac{1}{3}$	+ 100 p.c.†
167	Rugby - - - -	„ $2\frac{1}{4}$ „ $7\frac{1}{2}$	+ 220 p.c.†

* For Cardiff diarrhœa and dysentery are reckoned together. And the earlier mortality doubtless includes some wholly exceptional Irish dysentery.

† In the two towns at the bottom of the list, the increase in diarrhœa mortality is largely to be ascribed to the prevalence of the disease in the respective workhouses.

sewage, the difference of all of them from Leicester, and again from towns that dispose of their sewage in other ways are reflected in a singularly precise manner in the table that shows reduction of typhoid fever.

Of course, it is not contended that the risk of sewer gas escaping from pipes into houses is confined to those towns that pump their sewage: only that the accumulation of sewage to a height in a pumping well with the outfall-pipe under water and with scanty exit behind, is a constructive arrangement particularly liable to permit the delivery of sewer gas into houses. Two examples were met with of towns with other conditions of outfall, where fever had been traced distinctly to the backing up of water in pipe sewers. The one is Morpeth, where occasional outbreaks of typhoid had followed times of flood when the outfall sewer had been under water. The other is Croydon, where in 1853 a memorable outburst of fever coincided with a proved delivery of sewer gas into houses. Here, although great pains have since been taken by ventilating the sewers to remove this risk, a recent outbreak of typhoid fever (1866) has occurred with accidents almost identical with those of Worthing, sewer gases having been heard noisily forced through the traps of inside waterclosets a few days before inmates of the house were stricken down with fever.

The majority of these towns exhibit for diarrhœa an improvement or an absence of improvement considerably resembling that of typhoid, but there are four or five conspicuous instances of reduction of fever in a town coinciding with an increase of diarrhœa. To some extent this may be accounted for by the lax use of terms in the death registers of certain towns, more particularly in the case of young children, who are the chief contributors to mortality from diarrhœa.* But there remain sufficiently obvious differences between the fluctuations of mortality from typhoid and from diarrhœa to make it probable that other influences than those affecting fever have operated on the prevalence of epidemic diarrhœa.†

Cholera.

16. *Cholera epidemics* appear to have been rendered practically harmless in the towns examined. The following statement is eloquent of the effect of sanitary measures upon this disease. Unless where otherwise noted, the epidemic of 1849 found the town entirely unprepared, the attack of 1854 came while its works of drainage or water supply were in progress, and that of 1866 has found it in conditions of comparative cleanliness and purity. The towns are placed in the order in which they suffered in 1849, with the deaths from cholera per 10,000 of the population existing at each date, less than three cases not being reckoned :—

See page	Town.	1848–9.	1854.	1866.
79	Merthyr*	267	84	20
92	Cardiff†	208	66	$15\frac{1}{2}$
182	Alnwick	205	—	—
150	Salisbury	180	$14\frac{1}{2}$	—
121	Newport	112	$1\frac{1}{2}$	12
188	Brynmawr	100	—	—
58	Bristol	82	11	$1\frac{1}{2}$
129	Dover	40	10	$4\frac{2}{5}$
98	Croydon	27	21	2
105	Carlisle	22	6	—
198	Morpeth	14	$11\frac{1}{2}$	—
135	Warwick‡	$10\frac{1}{2}$	—	—
113	Macclesfield	9	1	—
172	Penrith	$9\frac{1}{2}$	—	—
155	Chelmsford	4	$2\frac{1}{2}$	—
141	Banbury	2	10	—
70	Leicester	1	—	—
86	Cheltenham§	—	$1\frac{1}{2}$	—
145	Penzance	—	—	—
161	Ely	—	28	—
167	Rugby	—	—	—
177	Stratford	—	—	—
193	Worthing	—	—	—
203	Ashby	—	—	—
—	Ottery	—	—	—

* 1854 before any public works, but some improvement in cleansing. 1866 town still undrained, but good water and other progress.
† 1854 before any public works, but some improvement in cleansing.
‡ 1854 before drainage and works done. § 1854 before the new public works done.

* On certain registers the name diarrhœa as a cause of death scarcely ever occurs before the practice became general (in 1845) of obtaining medical certificates of the cause of death. From that time such registers contain fewer of those popular names which, without naming diarrhœa, may well have been the more popularly observed conditions accompanying it. Bristol is probably an instance of this, among others.

† In the confusion habitually made of many sorts of disease under the name of diarrhœa, an investigation of the epidemic form has necessarily assumed a constant rate of prevalence for those other forms of diarrhœa which are not epidemic, and have nothing to do with local influences. But it is not certain that this assumption is always well founded.

APPENDIX.

No. 2.
On Results of Works, &c., for promoting Public Health, by Dr. Buchanan.

SUMMARY REPORT.

Phthisis, and subsoil water.

17. *Phthisis,* including under this head all deaths registered as "consumption," has in certain towns undergone positive diminution: the amount of reduction being frequently very considerable, from a third to a half of the whole mortality from this cause having been removed.* In other towns phthisis has been stationary, or has even increased.

The sanitary improvement that coincides with decrease of phthisis in town after town, with least frequent exception, is the drying of the ground on which the town stands. As this result has not always been specially aimed at by those who executed sewerage works, so it is very difficult to get a measure of the degree to which it has been effected. Referring for details to the account of each town, the amount of drying of subsoil is stated below in as accurate general terms as may be. Here the change of mortality is exhibited separately for females of the middle period of life, and figures representing reduction or increase are given per cent. of the death rate formerly prevailing :—

Reduction of phthisis.

See page	Town.	Previous phthisis death rate (all ages) per 10,000 annually.	Degree of change in phthisis death rate.		Influence of sewerage works on subsoil.
			In total.	In females 15–55.	
150	Salisbury - -	$44\frac{1}{3}$	−49 p.c.	?	Much drying.
161	Ely - - -	32	−47 p.c.	?	Much drying.
167	Rugby - -	$28\frac{1}{2}$	−43 p.c.	−48 p.c.	Some drying.
141	Banbury - -	$26\frac{2}{3}$	−41 p.c.	−36 p.c.	Much drying.
193	Worthing - -	$30\frac{1}{2}$	−36 p.c.	−41 p.c.	Some drying.
113	Macclesfield -	$51\frac{1}{2}$	−31 p.c.	−22 p.c.	Much drying.
70	Leicester -	$43\frac{1}{3}$	−32 p.c.	−16 p.c.	Drying, see text.
121	Newport - -	37	−32 p.c.	−13 p.c.	Local drying.
86	Cheltenham - -	$28\frac{3}{4}$	−26 p.c.	−25 p.c.	Some drying.
58	Bristol - -	$33\frac{1}{2}$	−22 p.c.	−18 p.c.	Some drying.
129	Dover - - -	$26\frac{1}{3}$	−20 p.c.	−18 p.c.	Local drying.
135	Warwick - -	40	−19 p.c.	−10 p.c.	Some drying.
98	Croydon - -	†	−17 p.c.	?	Much drying.
92	Cardiff - -	$34\frac{3}{4}$	−17 p.c.	?	Much drying.
79	Merthyr - -	$38\frac{1}{2}$	−11 p.c.	−12 p.c.	Some recent drying.
177	Stratford - -	$26\frac{2}{3}$	− 1 p.c.	− 4 p.c.	Some local drying.
145	Penzance - -	$30\frac{3}{4}$	− 5 p.c.	± 0	No change.
188	Brynmawr - -	$28\frac{1}{3}$	+ 6 p.c.	− 8 p.c.	No notable change.
198	Morpeth - -	$30\frac{1}{2}$	− 8 p.c.	+12 p.c.	No change.
155	Chelmsford - -	$32\frac{1}{2}$	± 0	+11 p.c.	Slight drying.
172	Penrith - -	$39\frac{1}{3}$	− 5 p.c.	+27 p.c.	No change.
203	Ashby - -	$25\frac{1}{2}$	+19 p.c.	−10 p.c.	Some drying.
105	Carlisle - -	32	+10 p.c.	+11 p.c.	Drying, with local [defects.
182	Alnwick - -	$28\frac{1}{2}$	+20 p.c.	+36 p.c.	No drying.

Change in subsoil water.

The effect of sewerage works on subsoil water has been judged of by the facts of shallow wells being dried or their water lowered, springs being intercepted by the sewers, and cellars that had been flooded by ground water ceasing to be flooded; but it must be confessed that in some instances (especially of towns visited in the early part of the inquiry before the point appeared to have much importance) the belief

* Fluctuations in nomenclature, different views as to diagnosis by doctors, improved resources for curing consumption, are accidents calculated to produce, and that doubtless have produced, an effect on the appearance of this disease on death registers. But none or all of them could have produced any effect, either in degree or kind, like that which is shown by the table to have been exerted on phthisis.

† Phthisis and lung diseases together previously $59\frac{1}{2}$. Reduction of this rate is what is above given.

that subsoil water has or has not been lowered or removed rests less on such evidence than on the statement of the fact by the town surveyors.

Connexion of phthisis with subsoil water.

Taking all towns below Stratford on the foregoing list as having been unimproved in their rate of mortality from consumption, there is seen a large and pretty constant connexion between the fluctuations of this disease and the charges effected on the subsoil water, and the two have varied very closely to the same degree. In Leicester indeed (a large town where short periods may be more relied on) a time of greater reduction in subsoil water corresponded with a greater reduction in phthisis mortality, which then had subsided by 41 per cent. of its previous amount at all ages, and by 32 per cent. in the death rate of females at the middle age of life. This was during the time that sewerage works were in progress and for a short period after. Since the completion of the works there is reason to believe that water has risen again in the subsoil, while the phthisis death rate has somewhat risen also, but still remains much below its original amount. During the sanitary works at Stratford also (a less important town) a large reduction of phthisis was for the time observable; but as a rule the reduction of mortality from this cause was uniformly progressive through the time of sewering the town.

Exceptions thereto.

As to the method of sewerage, it is to be noted that those towns have conspicuously improved which have had special arrangements made for drying their subsoil, as Salisbury; those which have got large sewers all stand well; and so do others where deep storm culverts have been provided in addition to the pipe system. Failure to reduce consumption is most observable, either where the soil already contained little water (as at Penzance and Brynmawr), or where—the storm water passing by the surface or in superficial drains—the deep drainage consisted of impervious pipes laid down in compact channels (as at Penrith and Alnwick), so that no extensive drainage of water could occur, either through or alongside them.

To the general preciseness of connexion between phthisis and subsoil water, there are indeed only four exceptions which, curiously, are in the case of four towns already grouped together; only, in this case, two of them are an exception in the one direction, and two of them in the opposite. Carlisle and Chelmsford appear to have got their ground water removed more than some towns that stand better in reduction of phthisis, and Worthing and Rugby seems to have had more influence exerted on phthisis than in other towns where the removal of subsoil water was more complete. Perhaps it had better be confessed that there are exceptions to the rule of subsidence of phthisis after drying of subsoil; or the suggestion may be allowed that the nature of the change in climatic conditions, produced by drying the subsoil of a locality, is not everywhere the same (the environs of Chelmsford, for example, still get flooded through the action of a milldam), and that different degrees of effect may hence be produced on consumption.

It does not seem by the removal of excreta and house-slop that the sewerage of towns has acted to reduce the amount of their death-rate by consumption. The order of the phthisis list of towns is by no means that of the list given for typhoid fever, which was shown to be chiefly affected by the removal of such organic impurity. Many of the towns at the bottom of the last list, such as Alnwick and Brynmawr, have achieved the greatest possible progress in the removal of their filth; and it has been stated that Rugby and Worthing stand very high on the list for improvement of phthisis, while Chelmsford and Carlisle are near the bottom. For several towns the suggestion may be made that better water, or improved lodgment of people, has influenced phthisis; but if so, their effect has been of no great constancy or magnitude.

Appendix.

No. 2.
On Results of Works, &c., for promoting Public Health, by Dr. Buchanan.

Summary Report.

Lung diseases.

18. *Diseases of the lungs*, other than consumption, have undergone no regular reduction in their amount in the several towns. In some places where the best results have been produced upon other causes of death, there has been some increase in the mortality from lung disease, mainly, it is true, among old people, who, it may well be believed, having had their lives prolonged by the subsidence of other causes of death, died afterwards from the lung disorders incident to old age.* But neither directly nor inversely did the class of lung disease fluctuate according to the fluctuations of phthisis. In the larger towns that were visited, it has sometimes appeared that occupational differences have affected the mortality from lung diseases, but there is no physical alteration, or set of alterations produced by public sanitary work, that can in any way be plausibly associated with changes in the amount of mortality from these causes.

Social improvement.

19. The progress made by the inhabitants of most of the 25 towns in decency, cleanliness, self-respect, and morality, was, at the least, as striking as the improvement in their health measured by the mortality returns.

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* Here and there a similar increase was observed in the few cases of phthisis fatal after 55, when phthisis at working ages was much reduced, suggesting that the fatal event of a constitutional disposition was delayed. Increase is also often noticeable in the brain diseases of old people, probably for the cause above suggested in respect of lung diseases.

Index to towns reported on.

Alphabetical Order of Towns visited, and Reference to Pages where each Town is mentioned in the Report.

(*Note that particular towns are placed in the following pages in the order of their size; but that this order by no means represents the degree of value of each town for the purposes of the inquiry.*)

No. 2.

General scheme.

GENERAL SCHEME, showing broadly the connexion between physical and social

GENERAL NOTES.

The mere regulation of an ordinary number of common lodging houses is not reckoned as a reduction of overcrowding.

In this table, where subsoil or cesspools unchanged, sewerage here means removal of surface water and liquid house filth.

Towns in the order of population, 1861.	Nature of change effected in town, as to drying of subsoil, removal of excreta, supply of water, cleanliness, lodgment of people, and (where notable) in industrial circumstances.	Nature of change in rate of mortality				
		Total deaths.		All causes under 1 year.	Measles.	Scarlatina.
Bristol with Clifton, 160,714.	Some recent removal of subsoil water. Thorough sewerage by large sewers. Substitution recent of W.C. for the previous cesspool. Increased supply of water and disuse of wells. Improved cleansing and inspection. Crowding until quite recent periods as before. Result not fully exhibited as would be if exact boundaries observed.	Reduced from 245½ to 242.	− 1½ p. c.	− 2 p. c.	− 50 p. c.	+ 43 p. c.
Leicester, 68,056.	Drying of subsoil, probably not so great lately as when works first done. Thorough sewerage by a double system of storm (large) and soil (pipe) sewers. Partial substitution of W.C. for middens (*b*). Supply of water (*a*) to an increasing proportion of people. Purification of well supply to the rest. Better paving and cleansing (*a*). No notable crowding at any time. Industrial depression followed by exaggerated amount of employment, both since operation of drainage, &c. works. *See Note.*	Reduced from 264 to 252.	− 4½ p. c.	+ 1 p. c. (reduced during works).	− 55 p. c.	+ 180 p. c.
Merthyr Tydfil, 52,778.	Very recent change in subsoil water. Sewerage very recently available (large sewers). Good and copious water supply in place of very scanty and foul. Progress in cleansing and paving. Decrease in density of population.	Reduced from 332 to 262.	− 21 p. c. (or allowing for cholera − 12½ p. c.)	− 24 p. c.	− 7 p. c.	+ 60 p. c.
Cheltenham, 39,693.	Some lowering of subsoil water. Thorough sewerage (by large sewers) partly done before. Progressive substitution of W.Cs. for old dry wells. Some extension of company's water supply and purification of wells. Better cleansing and paving. No notable crowding to be reduced.	Reduced from 194 to 185.	− 4⅓ p. c.	− 8 p. c.	+ 50 p. c.	− 30 p. c.*
Cardiff, 32,954.	Much removal of subsoil water. Thorough sewerage by large sewers. W.Cs. newly supplied and substituted for use of streets and common privies. Good and ample water supply in lieu of scanty and bad. Improved paving and cleansing. Great reduction of overcrowding. Exaggerated amount of employment during the period of sanitary operations; normal before and after.	Reduced from 332 to 226.	− 32 p. c. (or allowing for cholera − 24 p. c.)	About − 22 p. c.	− 25 p. c.	+ 90 p. c.
Croydon, 30,229.	Drying of subsoil. Thorough sewerage, but imperfectly ventilated. Water culverts for subsoil, &c. water and pipes for soil. W.Cs. in lieu of cesspools. Good water supply instead of scanty and bad. Better paving and cleansing. Reduction of overcrowding. Improvement in social position of bulk of people resident in town. Increased birth rate.	Reduced from 237 to 190.	− 20 p. c. (or allowing for cholera − 18½ p. c.)	+ 10 p. c.	− 62 p. c.	− 20 p. c.

Note to Leicester.—Works of different kinds were here done at different times, an earlier (*a*) and a subsequent (*b*). The date when appearance of change of prevailing disease comes on registers is signified (when not progressive) by the same letters.

* Reduction doubtless connected with a bad epidemic during sanitary works.

changes in 25 towns, and the fluctuations of mortality from certain causes.

- - - - - - GENERAL NOTES.

A double line under certain figures denotes that the actual previous rate of prevalence of a disease was high.
Increase (+) or reduction (–) "p.c." means per cent. of the previous rate of mortality from any cause, the mean of years before and after work being taken. In the "lung" col., the age chiefly affected by the change is noted. In the cholera column (α) (β) and (γ), signify that the epidemic occurred (α) before (β) during (γ) after sanitary operations.

(per 10,000) before and after chief operations of other column.

Pertussis.	Fevers (excluding typhus).	Diarrhœa.	Phthisis.		Lung diseases.	Town.	Cholera deaths per 10,000 of their existing population.
			Total.	Females, 15–55.			
+ 21 p. c.	– 33 p. c.	+ 40 p. c.	– 16 p. c.	– 18 p. c.	– 2 p. c.	Bristol with Clifton.	1849 (α) 82. 1854 (β) 11. 1866 (γ) 1½.
+ 20 p. c. (*a*)	– 48 p. c. (*b*)	+ 20 p. c. (*a*)	– 41 p. c. (*a*) then rise of 9 p. c., leaving – 32 p. c. in later years.	– 32 p. c. then rise of 16 p. c., leaving – 16 p. c.	+ 28 p. c. (aged)	Leicester.	1848-9 (α) 1½. 1854 (β) 0. 1866 (γ) 0¼.
– 20 p.c.	– 60 p. c.	– 45 p. c.	– 11 p. c.	– 12 p. c.	+ 16 p. c. (infants)	Merthyr Tydfil.	1849 (α) 267. 1854 (α) 84. 1866 (β) 20.
– 33 p. c.	– 37 p.c.	– 16 p. c.	– 26 p. c.	– 25 p. c.	+ 3 p. c. (aged)	Cheltenham.	1849 (α) 0. 1854 (α) 1¼. 1866 (γ) 0.
– 5 p. c.	– 40 p. c.	– 75 p. c.*	– 17 p. c.	?	– 4 p. c.	Cardiff.	1849 (α) 208. 1854 (α) 66. 1866 (γ) 15½.
– 37 p. c.	– 63 p. c.	– 30 p. c.	– 17 p. c.			Croydon.	1849 (α) 27. 1854 (β) 21. 1866 (γ) 2.

* The mortality from diarrhœa in Cardiff includes dysentery, which in the earlier period examined was probably epidemic in a whole exceptional manner.

GENERAL SCHEME, showing broadly the connexion

Towns in the order of population, 1861.	Nature of change effected in town, as to drying of subsoil, removal of excreta, supply of water, cleanliness, lodgment of people, and (where notable) in industrial circumstances.	Nature of change in rate of mortality				
		Total deaths.		All causes under 1 year.	Measles.	Scarlatina.
Carlisle, 29,417.	Drying of subsoil, except in a large poor area. Thorough sewerage by pipes. Storm water mainly removed by surface. Substitution in parts of W.Cs. for middens. Increased supply of good water, but less pure of recent years. Better paving and cleansing. Reduction of overcrowding. But considerable portions of town unimproved.	Reduced from 284 to 261.	− 8 p. c. (or allowing for cholera − 7 p. c.)	− 8 p. c.	− 9 p. c.	− 25 p. c.
Macclesfield, 27,475.	Drying of subsoil. Partial well done sewerage, by pipes added to old system. Middens retained, but drained and improved. Extension of water supply and disuse of impure sources. Much better paving and cleansing. Reduction of overcrowding. Some want of employment in later years.	Reduced from 298 to 237.	− 20 p. c.	− 23 p. c.	− 30 p. c.	− 45 p. c.
Newport, Monmouthshire, 24,756.	Local drying of subsoil (*b*). Extension and improvement of (large) sewerage (*b*). Substitution of many W.Cs. for cesspools and the streets (*b*). Extension of existing water supply (*a*). Progress in paving, cleansing, and nuisance removal (*a*). Some decrease in density of population (*b*). *See Note.*	Reduced (*a*) from 318 to 216.	− 32 p. c. (or allowing for cholera and dysentery − 23 p. c.)	− 21 p. c.	− 33 p. c. (*b*)	+ 18 p. c.
Dover, 23,108.	Local drying of subsoil. Improvement and extension of sewerage, by addition of pipe sewers to old system. W.Cs. in lieu of cesspools and privy tubs, but some only lately done. Copious good water supply in lieu of scanty supply, some of which bad. Improved paving and cleansing. No change of note in conditions of lodgment.	Reduced from 225½ to 209.	− 7¼ p. c. (or allowing for cholera − 6 p. c.)	− 3 p. c.	+ 50 p. c.	− 64 p. c.
Warwick, 10,570.	Some drying of subsoil. Thorough main drainage, by the addition of a pipe system, private being made gradually. Much substitution of W.Cs. for middens. Extension of water supply and improvement of quality. Paving, cleansing, and inspection. No crowding at any time.	Reduced from 227 to 210.	− 7½ p. c.	− 9 p. c.	+ 50 p. c.	− 25 p. c.
Banbury, 10,238.	Drying of subsoil. Thorough sewerage by large mains and pipes. Substitution of W.Cs. for cesspools and middens. Good water supply instead of shallow well water of unknown quality. Paving and cleansing much better. No overcrowding at any time.	Reduced from 234 to 205.	− 12½ p. c.	− 15 p. c.	+ 160 p. c.	− 37 p. c.
Penzance, 9,414.	No change in subsoil water. Quite recently thorough sewerage by pipes, storm water going off by surface. Substitution of W.Cs. for cesspool or use of street. New and more copious water supply replacing scanty but presumably good well water. Better cleansing and recent paving. No change in lodgment.	Stationary at 221–222.	± 0	± 0	− 60 p. c.	+ 20 p. c.

Note to Newport.—Works of different kinds were here done at different times, an earlier (*a*) and a subsequent (*b*). The date when appearance of change of prevailing disease comes on registers is signified (when not progressive) by the same letters.

between physical changes, &c.—*continued.*

per 10,000) before and after chief operations of other column.						Town.	Cholera deaths per 10,000 of their existing population.
Pertussis.	Fevers (excluding typhus).	Diarrhœa.	Phthisis. Total.	Phthisis. Females, 15–55.	Lung diseases.		
+ 30 p. c.	− 2 p. c.	+ 10 p. c.	+ 10 p. c.	+ 11 p. c.	+ 23 p. c. (infants)	Carlisle.	1849 (α) 22. 1854 (β) 6. 1866 (γ) 0.
− 25 p. c.	− 48 p. c.	− 3 p. c.*	− 31 p. c.	− 22 p. c.	+ 14 p. c. (infants)	Macclesfield.	1849 (α) 9½. 1854 (β) 1. 1866 (γ) 0.
− 50 p. c. (b)	− 36 p. c.	− 40 p. c.	− 32 p. c.	− 13 p. c.	− 15 p. c. (infants)	Newport, Monmouthshire.	1849 (α) 112. 1854 (β) 1½. 1866 (γ) 12.
− 30 p. c.	− 36 p. c.	− 26 p. c.	− 20 p. c.	− 18 p. c.	+ 14 p. c. (aged)	Dover.	1849 (α) 40. 1854 (β) 10. 1866 (γ) 4⅔.
+ 60 p. c.	− 52 p. c.	+ 40 p. c.	− 19 p. c.	− 10 p. c.	− 22 p. c. (various) ages.	Warwick.	1849 (α) 10. 1854 (α) 0. 1866 (γ) 0.
+ 10 p. c.	− 48 p. c.	− 45 p. c.*	− 41 p. c.	− 36 p. c.	± 0	Banbury.	1849 (α) 2. 1854 (β) 10. 1866 (γ) 0.
+ 19 p. c.	+ 6 p. c.	+ 75 p. c. but dysentery gone.	− 5 p. c.	± 0	+ 28 p. c. (aged)	Penzance.	1848–9 (α) 2. 1854 (β) 0 1866 (γ) 2.

* A large proportion of the diarrhœa deaths at all periods were among workhouse inmates.

GENERAL SCHEME, showing broadly the connexion

Towns in the order of population, 1861.	Nature of change effected in town, as to drying of subsoil, removal of excreta, supply of water, cleanliness, lodgment of people, and (where notable) in industrial circumstances.	Nature of change in rate of mortality				
		Total deaths.		All causes under 1 year.	Measles.	Scarlatina.
Salisbury, 9,030.	Drying of subsoil. Thorough sewerage by large sewers specially contrived to remove subsoil water. Substitution of W.Cs. for cesspools. Ample supply of pure water in place of scanty and bad. Much improvement in paving and cleansing. No overcrowding at any time.	Reduced from 275 to 219.	− 20 p. c. (or allowing for cholera − 9 p. c.)	− 7 p.c.	− 11 p. c.	+ 300 p. c.
Chelmsford, 8,664.	No notable change of subsoil water. Thorough sewerage by pipes. Plenty W.Cs. in lieu of scanty privies with C.Ps. Substitution of good water supply (not very copious) in place of hard and scanty water. Cleansing and paving improved. No change in lodgment.	Increase from 196⅓ to 215.	+ 9½ p. c.	− 3 p.c.	− 53 p. c.	+ 280 p. c. + much diphtheria.
Ely, 7,847.	Drying of subsoil. Thorough sewerage by pipes for soil and special storm sewers. Substitution of W.Cs. for cesspools. River water copious instead of former scanty and bad supply, but probable contamination of river supply. Improved paving and cleansing. No overcrowding at any time.	Reduced* from 239 to 205½.	− 14 p. c.	− 19 p. c.	− 90 p. c.	+ 220 p. c.
Rugby, 7,818.	Some (not much) drying of subsoil. Thorough sewerage by pipes. Substitution of W.Cs. for cesspools and middens. Incomplete supply of good water instead of scanty and bad water. Better paving and cleansing. Some increase of crowding.	Reduced from 191 to 186.	− 2½ p. c.	+ 6 p.c.	− 43 p. c.	± 0
Penrith, 7,189.	No drying of subsoil. Sewerage moderately complete, pipes newly provided. W.Cs. partly substituted for middens. Insufficient water supply provided, replacing scanty and bad water. Better paving and cleansing, but many parts unimproved. Slight overcrowding remaining.	Reduced from 253½ to 250.	− 1 p. c.	± 0	+ 30 p. c.	− 45 p. c.†
Stratford-on-Avon. 6,823.	Local lowering of subsoil water. Thorough sewerage by pipes with large outfall. Middens retained, but drained and improved. Retention of surface wells, but removal of contamination from them. Very little improvement in paving, some in cleanliness. Increased density of population and some crowding.	Reduced from 217 to 202.	− 7 p. c.	+ 4 p. c.	+ 190 p. c.	+ 95 p. c.
Alnwick, 6,494.	No drying of subsoil. Thorough sewerage by pipes. Thorough substitution of W.Cs. for middens, but middens still largely foul with pig ordure, &c. Ample good water supply in addition to water from public "pants" which remain. Improved paving and cleanliness. Slight overcrowding remaining.	Reduced from 262 to 247.	− 6 p. c. (or allowing for cholera + 6.)	− 2 p. c.	+ 7 p. c.	+ 2 p. c.
Brynmawr, 6,334.	Inconsiderable drying of subsoil. Thorough sewerage by pipes with large outfall. Substitution of ample W.Cs. for scanty privies with cesspools and use of streets. Copious good water in lieu of scanty and bad. Great improvement in paving and cleansing. No change in lodgment of people.	Reduced from 273 to 232.	− 15 p. c. (or allowing for cholera − 11 p. c.)	− 10 p. c.	− 45 p. c.	− 33 p. c.

* Or, on a higher estimate of population before 1850, the reduction is from 228 to 205½ or − 10 p. c.
† Reduction doubtless connected with a bad epidemic during sanitary works.

between physical changes, &c.—*continued.*

(per 10,000) before and after chief operations of other column.						Town.	Cholera deaths per 10,000 of their existing population.
Pertussis.	Fevers (excluding typhus).	Diarrhœa.	Phthisis. Total.	Phthisis. Females, 15–55.	Lung diseases.		
− 28 p. c.	− 75 p. c.	− 60 p. c.	− 49 p. c.	?	+ 3 p. c. (children)	Salisbury.	1849 (α) 180. 1854 (β) 14½. 1866 (γ) ? 1.
+ 10 p. c.	+ 5 p. c.	+ 14 p. c.	± 0	+ 11 p. c.	+ 24 p. c. (infants)	Chelmsford.	1849 (α) 4. 1854 (β) 2½. 1866 (γ) 0.
+ 18 p. c.	− 56 p. c.	+ 7 p. c.	− 47 p. c.	?	+ 12 p. c. (aged ?)	Ely.	1849 (α) 1. 1854 (β) 28. 1866 (γ) 2½.'
− 25 p. c.	− 10 p. c.	+ 220 p. c. partly workhouse.	− 43 p. c.	− 48 p. c.	− 10 p. c. (adults)	Rugby.	1849 (α) 1. 1854 (β) 0. 1866 (γ) 0.
− 33 p. c.	− 55 p. c.	+ 25 p. c.	− 5 p. c.	+ 27 p. c.	− 9 p. c. (aged)	Penrith.	1846 (*sic*) (α) 9½. 1854 (β) 0. 1866 (γ) 0.
+ 56 p. c.	− 67 p. c.	− 50 p. c.	− 1 p. c.‡	− 4 p. c.	− 27 p. c. (various)	Stratford-on-Avon.	1849 (α) 0⅔. 1854 (β) 0. 1866 (γ) 0.
± 0	− 36 p. c.	− 33 p. c.	+ 20 p. c.	+ 36 p. c.	+ 44 p. c. (extremes)	Alnwick.	1849–50 (α) 205. 1854 (β) 0. 1866 (γ) 0.
− 75 p. c.	− 56 p. c.	− 5 p. c.	+ 6 p. c.	− 8 p. c.	+ 10 p. c. (infants)	Brynmawr.	1849 (α) 100. 1854 (β) 0. 1866 (γ) 0.

‡ But a reduction of 22 p. c. during sanitary works.

GENERAL SCHEME, showing broadly the connexion

Towns in the order of population, 1861.	Nature of change effected in town, as to drying of subsoil, removal of excreta, supply of water, cleanliness, lodgment of people, and (where notable) in industrial circumstances.	Nature of change in rate of mortality				
		Total deaths.		All causes under 1 year.	Measles.	Scarlatina.
Worthing, 5,805.	Much drying of subsoil. Thorough sewerage by pipes. Unventilated pipe sewers in lieu of cesspools. Copious good water supply in lieu of scanty hard water. Better cleansing. No change in lodgment.	Reduced from 155 to 153.	− 1 p.c.	− 8 p.c.	+ 80 p.c.	+ 105 p.c.
Morpeth, 4,490.	No drying of subsoil. Thorough sewerage, pipes and large outfall. Partial substitution of W.Cs. for middens. New water supply in addition to old, but still sometimes amount scanty. Improvement in paving and cleansing. No overcrowding at any time.	Reduced from 262 to 247.	− 6 p.c. (or allowing for cholera − 5 p.c.)	+ 3 p.c.	− 45 p.c.	− 46 p.c.
Ashby-de-la-Zouch, 3,840.	Drying of subsoil. Thorough sewerage by pipes. Partial substitution of W.Cs. for middens. New ample water supply in lieu of bad water from surface wells, but a few wells still used. Better paving and cleansing. No overcrowding at any time.	Reduced from 216 to 202½.	− 9 p.c.	− 35 p.c.	None in the 7 years before works, and not much afterwards.	
Ottery St. Mary, 2,429.	No change in subsoil water. Thorough sewerage by pipes. W.Cs. in lieu of open cesspools. Good and fairly copious water supply in place of scanty and bad. Better paving and cleansing. Reduction of overcrowding.	Probably stationary -		——	An increase	A great reduction.

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BRISTOL and CLIFTON (Registration Districts.)—Population (1861) 66,027 and 94,687 respectively, together 160,714.

Prefatory.

It is to be observed that in this city the limits of the mortality inquiry are not coincident with the boundaries of the Parliamentary borough of Bristol, which is the jurisdiction of the Bristol Local Board of Health. It was necessary to take such figures as existed ready prepared in the Registrar General's office, and for this purpose the registration districts alone were available. The difference is of some magnitude. The registration districts comprised large country parishes (with a population of 20,000 odd) in the Clifton Union that are not in the Parliamentary borough, and conversely they do not include a large portion of the Bedminster Union (with a population of 20,000 odd) which does lie within the borough. Practically, however, the statistical information obtained about the registration districts may be safely applied to the borough, if it is remembered (1) that the absolute mortality will, in this way, be represented a little too low, and (2) that any charge that may have resulted from sanitary works in the borough will come out less conspicuously than if the proper Parliamentary limits were followed. In taking the registration districts separately (which on other grounds cannot always be safely done) the foregoing considerations will apply to the Clifton district only.

Sanitary condition before 1850.

The condition of the city of Bristol previous to the operation of recent sanitary measures is described in the following extracts from the report of the superintending inspector (Mr. Clark) of the General Board of

between physical changes, &c.—*continued.*

(per 10,000) before and after chief operations of other column.						Towns.	Cholera deaths per 10,000 of their existing population.
Pertussis.	Fevers (excluding typhus).	Diarrhœa.	Phthisis. Total.	Phthisis. Females, 15–55.	Lung diseases.		
– 70 p. c.	+ 23 p. c.	+ 16 p. c.	– 36 p. c.	– 41 p. c.	+ 26 p. c. (aged)	Worthing.	1849 (α) 0. 1854 (β) 2. 1866 (γ) 0.
+ 83 p. c.	– 40 p. c.	+ 70 p. c.	– 8 p. c.	+ 12 p. c.	+ 28 p. c. (extremes of life.)	Morpeth.	1849 (α) 14½. 1853 (*sic.*) (β) 11½. 1866 (γ) 2.
None in the 7 years before works, and not much afterwards.	– 56 p. c.	+ 100 p. c. (all excess in workhouse.)	+ 19 p. c.	– 10 p. c.	± 0	Ashby-de-la-Zouch.	1849 (α) 3. 1854 (β) 0. 1866 (γ) 0.
——	Probably a reduction.	Probably a reduction in children.	Either stationary or increased.		——	Ottery St. Mary.	1849 (α) 1. 1854 (γ) 1. 1866 (γ) 1.

Health, dated 1850. It may be premised that most of the " old city " of Bristol and much of the poorer part of Clifton Union are on a low level, while the suburb usually known as " Clifton " (and which has very little connexion except for administrative purposes, with the poor parishes of Bristol that lie in the union of Clifton) lies on very high and sloping ground. *Bristol and Clifton.*

" The course of the Avon through the city is tortuous, and the natural rise of the tide very considerable. In 1803–9, the channel of the Avon was formed into a floating harbour, and retained always full by means of gates and intermediate basins, while a new and direct channel for the Avon was made, including with the floating harbour a portion of the old city in a sort of island. The effect of this work was to retain the level of the Avon at or above high-water mark, and therefore to injure materially the natural drainage of the lowlands, and to render the sewage that discharges into the old channel much more offensive than when it found its way into a tidal stream. The low tracts bordering on the channel of the Avon are more or less subject to land floods. These tracts, though containing some populous districts, do not bear a very great proportion to the area of the whole city, most of which stands high with a good natural fall." *Site. River.*

The heights of the town are composed of a succession of rocks, mountain limestone, millstone grit, and coalmeasures at considerable inclination, dipping towards south and east. They are partly covered by horizontal beds of the new red sandstone formation. The lower parts of the city stand on 20–30 feet of alluvial deposit, with conglomerate rock below. The present tidal river and adjacent parts are in the new red sandstone. *Soil.*

" The climate of Bristol may in general terms be characterized as mild and somewhat damp. Including fogs and mists, rainy weather prevails for more than half the year. The prevalent winds are from the south and south-west, and sweep through Clifton and the higher parts

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of Bristol freely. But from the arrangement of streets in the lower parts of the city, that portion of it has not equal advantage; so that in this respect, independently of differences in exposure to sun and of temperature from different heights, the town and its suburbs vary materially.

Construction. "In the old town many of the streets are tortuous narrow and encumbered with ancient houses with overhanging upper stories. They are mostly crazy, lodging five to six families in accommodation intended only for one, and scarcely admitting of improvement short of reconstruction. Of late years much has been done in pulling down houses, laying out open spaces, and in various respects improving, especially those districts inhabited by the poor. There remains still much to be done. The suburbs are for the most part open and well arranged; these, however, contain the dwellings of the upper and middle classes; there is still a great want of well laid-out cottages for the poor."

Poverty. In the out parishes (Clifton Union) of St. Philip and St. Jacob, no less than 90 per cent. of the houses, while in Clifton (ordinarily known as such) only 30 per cent., are rated under 10*l*. In other parts of the city the proportion of such houses is intermediate, being 40 per cent. in the old city.

Sewerage. "The sewerage of the city is confined almost entirely to the old city "and to Clifton. The other districts can scarcely be said to be sewered. "The arrangement by which the Avon was converted into a floating "harbour at once deranged the whole of the existing system of sewerage, "inasmuch as it raised the outfall permanently 16 feet, and substituted "stagnant water for a tidal stream. The evil thus created was very partially remedied by the Dock Company. They conveyed portions of the "sewerage into the new cut, and employed 'Mylne's culvert,' that had "been made in 1827–8 for other purposes, to carry off other sewage into "the same stream." These sewerage arrangements, made in 1848–9, disposed of the sewage of 1,132 houses, carrying it into the new cut, the now tidal river, some above and some below the outer lock. Other sewers discharged into the channels of open brooks, and some entered the Frome river, whose contents were in dry seasons carried off by Mylne's culvert, and were not then allowed to enter the floating dock. But beside these, many sewers entered the comparatively stagnant water of the floating harbour, and the surplus waters and sewage of certain brooks also, in wet seasons, entered that basin. Beyond the old city the lowlying parts of Bristol and Clifton were very imperfectly sewered. Clifton (usually known as such) had three principal public sewers with ill-arranged outfalls into the river and the float. Private sewers were more numerous, but there was a general complaint throughout Clifton of insufficiency in drainage.

Cesspools were in common use in parts of Bristol and Clifton not immediately on the line of the main sewers, or of any ditch. The contents of such cesspools were, in many cases, pumped out into the road drain or the open gutter. In Clifton many new and excellent houses in the finest situations drained into cesspools and were absolutely without sewers at all.

Water supply. The water supply to Bristol and Clifton, up to 1847, was extremely insufficient and bad in quality. Into the old city certain springs were led by conduits, and at Clifton two springs had been similarly used. Their water was laid on to a very limited number of better-class houses. The poor people all had to fetch water from public pumps and wells, the water of which was in many cases impure. "In the lower parts of Clifton there are few wells, and many of them are affected by cesspools. Both in the higher and in the lower parts of the 'district' and in St. Philip and Jacob the want of water is universally complained of. In

the lower levels the wells are often mere pits in garden ground, the water of which is too filthy even for washing, and quite undrinkable."

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" In 1846, a company was incorporated for the supply of Bristol with " water. In 1847 a part of the supply was brought into the city," and at the date of Mr. Clark's report the whole works were approaching completion, and 3,152 houses were then actually supplied, but these were almost entirely of a class above the poor. The water was obtained from the Barrow, Lutton, and Chewton springs on the Mendip hills, and was estimated to furnish 4,000,000 gallons a day, being double what was then supposed to be required. Service reservoirs had been constituted, and a storage reservoir was in contemplation. The plan of constant high pressure service had been adopted. The water was somewhat hard (averaging 19°), but was much softer than that previously in use, and appears to have been found free from organic matter.

Paving and cleansing.

In the old city, in 1850, Mr. Clark found the main streets fairly paved, but the back streets often badly "pitched." The gutter grates were usually not trapped or only inefficiently. In other parts of Bristol and Clifton, except the highways, the condition of the roads was very defective. Scavenging was well done for the public streets of the old city, but elsewhere very imperfectly. Only a part of the town was lighted, and a very small part indeed well lighted.

Nuisances.

Mr. Clark's report gives copious illustrations of the nuisances that were to be met with in 1850, in all the poor parts and in many of the richer parts of Bristol and Clifton. Two instances may serve for examples of what was nearly a universal state of things. " A large court with 11 " houses ; at one end is a rain tank containing much rubbish, and without " a pump, and at present dry. There is a public privy in an extremely " disgusting state under a sleeping room. There are two cesspools " complained of. These cottages are much overcrowded, chiefly with " Irish . . . Deep Street has a narrow central gutter into which " house refuse is thrown. There are great complaints of the gutter " grates deing untrapped and out of order, and of the smells arising from " it. Here are heaps of ashes . . . Beneath the two arcades are " cellars said to be drained, but dark and very deficient in ventilation. " The smells are dreadful. The places are cleanly kept, but quite unfit " for the occupation of human beings." This illustration is from the older parts of Bristol ; the next may be from the recently growing parts of St. Philip and Jacob. " The roads in the neighbourhood are " unmade and in a very filthy state. Here is a public manure depôt, and " a most offensive knacker's yard adjoining a dwelling-house. Cholera " occurred in the neighbourhood. Fudge's court is very low and damp. " The house floors are lower than the ground. There is no water. " Matthew's knacker's yard contains a pigstye, manure heap, tub of " offal, and is badly paved ; all in a densely populated neighbourhood " . . . Dark Entry is very close and crowded. Heaps of ashes and " offal are thrown into the passage, of which one end is nearly blocked up " by such deposits." And nuisances from cesspools, ditches, drain effuvia, foul privies, pigstyes, and ash-heaps, were observed in proximity to some of the best rows of houses in Clifton.

Deficient privy accommodation was a nuisance constantly met with; cases are mentioned of one privy to 16 houses. And the privies, whether discharging into drains or cesspools, were in numberless instances found foul and offensive.

Lodgment.

Overcrowding appears to have been a very common condition. Instances are given by Mr. Clark of a house containing 33 adults; of another with four families including 21 children; of six people living in a room of 750 cubic feet; and the evil appears to have been pretty universal; the

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custom of living day and night in a single room prevailing in the poor parts, and particularly in the Irish quarters.

Sanitary measures since 1850.

The measures that have been adopted for improving the sanitary condition of Bristol have necessarily extended over a long period, and indeed the inquiring into their effects on health would most fitly begin with the present time, for not until now have improvements been fairly completed. But an account of what has been done and of the mortality statistics up to this time does already suggest some results of interest.

Water.

This account may commence with the water supply which had been introduced in 1847. The storage reservoir at Barrow was presently completed by an embankment across a valley enclosing 25 acres and 150,000,000 gallons of water. A new reservoir of still greater capacity and comprising 45 acres is now (1866) being constructed. The water is "screened" but is not filtered, and is conveyed by covered pipes and aqueducts through 10 miles of its course to Bristol. Every year an increasing number of houses is supplied by the water company, and something under 3,000,000 gallons a day are now delivered. The supply amounts to 20 gallons per head per day of the population supplied, but how much of this goes to the purposes of manufactures and breweries cannot be ascertained. The increase in supply may be judged of by the revenue of the company, which in 1847 was 2,000*l.*, in 1855 was 13,500*l.*, in 1860 was 17,910*l.*, and in 1865, was 23,500*l.* The supply is on the constant system, day and night, being occasionally stopped during the night when the storage reservoir is being drawn on. The pressure is sufficient to supply without pumping all but the highest parts of Clifton; these are supplied by a high service reservoir on the highest part (Durdham-down) of Clifton. Still, for all that the works were originally laid out on so large a scale, the supply is apt occasionally to run short in dry seasons. In 1864 the reservoirs were exceedingly low, and the company was put to great shifts to supply a reasonable amount. It was found, upon the occasion of an inquiry into the causes of an outbreak of typhus fever (in St. Philip and Jacob parishes particularly) in Jan. 1865, that there had been a serious lack of water in the poorer parts of the city. Under these circumstances the company has not only undertaken the construction of a new storage reservoir, but has some arrangements in hand for provided by pumping a greatly increased supply to their existing store at Barrow. Many provisions are in force to prevent waste of the water, and among others it is arranged that in outside waterclosets no system of water service shall be required, dependence being had for the cleanliness of such closets upon flushing by a bucket from the nearest tap. The landlords are held responsible that closets shall in this way be kept clean.

To nearly every house there is now a supply of company's water; generally inside the house, but in the case of courts the supply is often common to several houses. But the old surface wells are still in use, though not largely, and in 1866, in presence of cholera, many of them were closed for a while.

Sewerage.

The sewerage of Bristol was completed in its main design between 1854 and 1861. The junction of home drains with the sewer system has been progressing from 1861 to the present time. The first main sewer constructed was the high-level sewer of Clifton, discharging into the Avon at low-water mark, at Blackrock quarries by an outfall 5 by $4\frac{1}{2}$ feet in diameter. This sewer has various gradients from a steepest of 1 in 6 to the least of 1 in 300. Its depth below the surface is 10–70 feet, and its branches are 10–12 feet down. It is not ventilated or flushed, and is stated to require neither one nor the other as there is no deposit in it, and

never any accumulation of foul gases. Every inlet to street and houses is trapped, and only one air exit exists to allow for wind driving up the sewer in certain low tides. Every house in its district is now connected (usually by 9-inch pipes with a fall of 1 in 60) with this sewer, where before there were universally cesspools. This high level (Clifton sewer) was completed in 1856.

Then the low-level Clifton sewer was begun. The outfall sewer skirts the Avon, reaching the same outlet as the former. The average depth below the surface is 12 feet, deep enough to drain all the cellars; but in the district of this sewer the subsoil is kept wet by the water of the floating harbour. The sewer is in size and construction similar to the first one, and was completed in 1857.

Next, the Bedminster area was drained in 1857–8; more particular notice of this sewer is not needed, inasmuch as (though the lowlying and poor district of Bedminster wanted sewerage perhaps more than any other) the Bedminster part of the city is not included in the mortality section of the present inquiry. But one important effect of this portion of the sewer system requires to be noted, that it removed all sewage from the branch of the Frome, and from other streams which feed the floating docks.

The old city and the island between the dock and the river were (as has been said) formerly the best sewered parts of Bristol, and their sewerage has been amended and not replaced by the present authorities. Nearly the whole of this part lies low, and their sewers discharge into the new cut within the city, and into Mylne's culvert before described. The house drains are here mostly old and of brick, and some have a bad fall. By flushing from the harbour, however, the mains are kept fairly clean, and as sewers are found to be acting badly they are replaced from time to time by pipes.

Lastly, the Frome intercepting sewer was constructed in 1860–61, takes that portion of the lowlying district of Bristol and Clifton that does not enter Mylne's culvert, and passes as a long brick sewer to join the low-level Clifton sewer and thus to the outfall at Blackrock.

Effect of sewerage.

The effect of these large and deep sewers upon the subsoil water of the town is doubtless considerable, yet not so great as might at first sight appear; for, 1st, before their formation the employment of Mylne's culvert would have already affected the subsoil of a large area as much as practicable; and 2d, no considerable lowering of the subsoil water is possible in parts within the influence of the floating dock, which keeps the water up some 16 feet permanently above its natural ebb level; and, in fact, it is known that the wells (generally speaking) are unaffected in their supply of water by the sewerage. In parts of both Bristol and Clifton, however, there is no doubt that the underground water level has been lowered by the passing of the sewer through the porous soil.

The effect of the sewerage upon the removal of the excreta of the town has been very considerable. As the main works proceeded in each district old house drains were replaced by pipes in so far as anything was found to be wrong in the drainage of houses; and wherever cesspools existed they were replaced by a connexion with the sewer. But where nothing was known to be wrong, where there was a drain to a house and no offensive smell at the time, the old drains were left, so that up to the present time works of private drainage have been going on, and even at present some remain to be done.

Privies.

It has been mentioned that outside privies in Bristol are connected with sewers, but are not supplied with water service. They are made, not with the earthenware pan and trap, in the rough use of which by careless folks so much difficulty is experienced in other towns, but with

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a stone shoot and "eject" communicating with a 9-inch pipe, and the whole well set under rules printed by the local board and acted on in practice. Certainly the stone-traps or ejects often get blocked, but not more frequently (if so often) as under the customary arrangement of pan, trap, and wretched water supply of the poor quarters of most towns; while the construction allows of articles that are improperly thrown into the privy being easily pulled out, or flushed away. In the better sort of houses the ordinary forms of watercloset within the house are employed, and in such cases water is supplied to them by a two-gallon flushing box, which being arranged so that exit is allowed to the water only when the service is closed, prevents waste of water while effectually washing away the contents of the closet pan.

Paving.

The paving and channelling of streets and courts in Bristol and Clifton is now complete. From what was seen and reported there appears to be no place in which these requisites for external cleanliness are not in a satisfactory condition. But progress in these respects has been made almost wholly within the last five years, and since the chief works of sewerage (which necessarily involved disturbance of surface) were completed.

Cleansing.

The removal of dust and ashes has been done with a fair degree of efficiency for the whole of Bristol and Clifton since 1851. Some ash-bins are moveable, some fixed; of the latter kind 300 in various courts have been supplied by the local board and are kept in repair by them. All streets are traversed by the dust contractor twice a week. Scavenging is also done by contract twice every week, and in some parts daily. This also has been efficiently performed since 1851.

Inspection of interiors of houses, &c.

In 1851 an inspector was appointed to attend to complaints of nuisance. Others were shortly afterwards appointed to act under the chief inspector in supervising scavenging and such work by the contractors. The chief inspector also took charge of slaughter-houses and other like establishments within the city. Common lodging-houses were regulated immediately upon the passing of the Act of 1851, and have been kept in a much better condition since that time. Some proceedings have recently been taken to reduce overcrowding in other than common lodging-houses; the good effect of these has extended beyond the particular houses on which action was taken, and there is now no extended amount of overcrowding in the city. Some 30 to 40 houses have, in late years, been closed as unfit for human habitation, but no wide action has been taken for demolishing confined and ill-constructed houses in courts. Happily, in Bristol, there are always empty houses to be had, and great facilities for building in the suburbs exist, so that there is no inordinate difficulty in dealing with overcrowding. Some few groups of model lodging-houses have been erected in recent years.

In their recent proceedings for improving the health of their city, the local board of health has received very valuable assistance from the gentleman whom they have appointed to the somewhat anomalous office of "medical inspector." The title of medical officer of health has not been, apparently from some timorous reason of policy, conferred on Dr. Davies, but he has exercised, since his appointment in 1865, all the functions of such an officer with the utmost diligence. Before his appointment there had been no supervision or amendment of the lodgment of the people.*

* It was the epidemic of typhus fever in 1864 which led to the appointment of a medical inspector. Before his time the lodgment of the poorer classes, in respect of space and ventilation, remained (except in common lodging-houses) as bad as at Mr. Clark's inspection, and possibly worse.

In the course of the inspection made for the present inquiry through many of the worst parts of Bristol and Clifton, the operation of the several sanitary measures here detailed was readily observable; but it was also apparent that the full benefit of them had only just been obtained. There appeared no lack of water and of decent paving and privy accommodation in any—even the poorest parts; and overcrowding to any serious extent was not observed. And as compared with the state of the city when it was inspected in 1865, on account of epidemic typhus, notable sanitary progress was observable, and particularly a smaller degree of crowding in poor houses.

Present state.

Mortality statistics.

The influence of these measures upon public health in Bristol may be learned as far as it can yet be learned from the accompanying statistics. For two chief reasons, however, the information they convey is of inferior value. The one has been already mentioned that they do not apply with strictness to the precise area under the jurisdiction of the board of health; the other reason is, that they refer almost wholly to the transition period during which improvements have been making. From the introduction of partial water supply and of limited sewerage in 1847–8 down to the present time, sanitary progress has been continuous, and the separation of the last 20 years into periods affords instruction rather by showing what change in mortality has occurred during a regular course of improvement than by contrast of one period with the other. But the separation has been made of earlier from later years in the summary results which are subjoined.

The total death rate will be seen to have already undergone some slight reduction. In this, children under one year of age have partly, but not especially, shared. While a decrease has occurred in the death rate of small-pox and measles, scarlatina and whooping-cough have increased in their mortality. Diphtheria has newly made its appearance on the death records, and croup has caused more deaths than formerly. Fevers, taken altogether, have undergone only a slight reduction; but there happen to be fair data for distinguishing true rarely occurring typhus from the ordinary endemic typhoid, and it is found that in the latter the reduction has been consider able and regularly progressive. On the other hand, deaths in the typhus epidemic of 1864–5 have exceeded any previously recorded mortality from that disease.

In respect of cholera one of the most satisfactory results of sanitary activity is to be found in Bristol. The deaths in the epidemic of 1849 (when matters were in the state described by Mr. Clark) amounted to no less than 90 in the 10,000 in the Bristol district, and $74\frac{1}{2}$ in the 10,000 in Clifton district, the mean of the two districts giving a cholera death rate of 82. In 1854, the purer supply of water had extended, cleanliness had been promoted by new public arrangements, and nuisances were being partially removed: in that epidemic the cholera death rate was only 11 per 10,000, and alike in the two districts. While in 1866, with a thoroughly improved state of the city, and with the efficient services of the best of medical inspectors, the rate of death from cholera was only $1\frac{1}{2}$ in the 10,000.

Consumption has been somewhat reduced in its mortality, viz., first after 1848, the date of certain sanitary works; and a progressive improvement has since occurred coinciding with the extension of drainage and other operations through the city. The fall since 1848 has been, in persons between 15–55 years of age, from $27\frac{3}{4}$ to $22\frac{3}{4}$ per 10,000 annually in Bristol district; and in Clifton district, from $20\frac{1}{4}$ to $18\frac{1}{2}$. In Clifton the reduction would doubtless be greater, but for two considerations; first, that a workhouse of the Bristol Union gets its deaths

registered in this district, and a larger proportion of Bristol paupers now are placed there than formerly; and secondly, that the better parts of Clifton have become more and more a resort for consumptive invalids from various parts of England.—Disorders of the lungs, other than consumption, have altered scarcely at all in their rate of mortality. Nor have diseases of the brain undergone much change in total mortality; though in infants fewer deaths in proportion to population have recently been registered as occurring from convulsions and such disorders, yet in the middle ages of life, the tendency shown by this class of disease has been rather towards increase.

District of Bristol.—Summaries.

Per 10,000 of total Population yearly.	Before (as stated below) execution of Sanitary Works.		During (1852–1861) execution of Sanitary Works.	After (1862–5) execution of Sanitary Works.
	(11 years, 1838–48.)	(3 years, 1849–51.)		
Deaths from all causes at all ages - - -	285	305	$267\frac{1}{2}$	273
Or, excluding epidemic cholera] - - -	285	275	$266\frac{1}{2}$	273
	(3 years, 1840–42.)	(5 years, 1849–51.)		
Infants under one year, all causes.	$58\frac{1}{2}$	57	56	$53\frac{1}{2}$
males -	32·3	31·2	31·3	30·7
females -	26·2	25·8	24·8	22·9
	(5 years, 1838–42.)	(5 years, 1847–51.)		
Epidemic diseases:—				
Smallpox (all ages)	$12\frac{2}{3}$	5	4	$5\frac{2}{3}$
Measles - " -	10	$3\frac{2}{3}$	$7\frac{1}{2}$	$3\frac{1}{2}$
Scarlatina - " -	$7\frac{1}{3}$	$12\frac{2}{3}$	$7\frac{3}{4}$	16
Diphtheria - " -	—	—	1	$2\frac{1}{3}$
Whooping-cough " -	$6\frac{3}{4}$	$4\frac{2}{3}$	6	7
Croup - - " -	$2\frac{1}{3}$	$1\frac{1}{2}$	$1\frac{3}{4}$	$3\frac{2}{3}$
Erysipelas - " -	$2\frac{1}{2}$	2	1	$0\frac{3}{4}$
Ague - - " -	—	—	—	—
Continued fevers " -	$10\frac{2}{3}$	$12\frac{3}{4}$	$8\frac{2}{3}$	$10\frac{2}{3}$
Of which presumably typhus, all ages.	—	$1\frac{3}{4}$	—	$3\frac{1}{3}$
Typhoid, &c. " -	$10\frac{2}{3}$	11	$8\frac{2}{3}$	$7\frac{1}{3}$
0–5		2·7	2·3	2·3
5 upwards		8·4	6·4	5·0
Diarrhœa, all ages -	$2\frac{1}{3}$	12	$10\frac{2}{3}$	$10\frac{1}{3}$
0–5		8·8	8·6	7·9
5 upwards		3·3	2·1	2·5
Cholera - (all ages)	$0\frac{1}{2}$	(Epidemic 1849, 90.)	(Epidemic 1854, $11\frac{1}{2}$.)	(Epidemic 1866, about $1\frac{1}{2}$.)
Dysentery - " -	1	1	$0\frac{2}{3}$	$0\frac{2}{3}$

District of Bristol.—Summaries.—*continued.*

Per 10,000 of total Population yearly.	Before (as stated below) execution of Sanitary Works. (1838–42)	Before (as stated below) execution of Sanitary Works. (1847–51)	During execution of Sanitary Works. (1852–1861)	After execution of Sanitary Works. (1862–5)
Phthisis, all ages and both sexes.	42	36	32	$28\frac{1}{3}$
15–55 males	?	14·2	13·2	11·5
15–55 females	?	13·6	12·8	11·3
Lung diseases, all ages and both sexes.	$46\frac{1}{3}$	$49\frac{2}{3}$	$47\frac{1}{2}$	$45\frac{2}{3}$
0–5, both sexes		20·2	20·1	17·6
15–55 males		5·4	5·0	4·6
15–55 females		4·0	3·4	3·5
above 55, both sexes		18·5	18·0	19·2
Brain diseases, all ages and both sexes.	42	$33\frac{1}{3}$	$30\frac{1}{3}$	28
0–5 (both sexes)		15·9	13·1	12·3
5–35 ,,		4·4	3·3	2·7
35–55 ,,		3·8	4·1	3·7
55 upwards ,,		9·3	9·8	9·4

On this and the following tables it may be well to make the statement definitely, that the reason for more or fewer years being included in the earlier periods, is simply that the data available for each year were not the same, and for some years the register had not been analyzed at all. All the information that was accessible at Somerset House has been incorporated into these figures, and the symmetry of the table has been thought less of than the desirability of basing each numerical statement on the widest possible ground.

District of Clifton.—Summaries.

Per 10,000 of total Population yearly.	Before (as stated below) execution of Sanitary Works.		During (as below) execution of Sanitary Works.	After (as below) execution of Sanitary Works.
	(16 years, 1838–53.)		(7 years, 1854–60.)	(1861–5.)
Deaths from all causes, at all ages	$227\frac{1}{2}$		208	222
[Or, excluding epidemic cholera]	222		$207\frac{1}{2}$	222
	(1840–42.)	(1847–51.)	(1852–61.)	(1862–65.)
Infants under one year, all causes.	$52\frac{2}{3}$	$51\frac{1}{4}$	$49\frac{1}{3}$	50
Males	29·7	29·2	28·0	27·5
Females	23·0	22·0	21·4	22·6

District of Clifton.—Summaries.—*continued.*

Per 10,000 of total Population yearly.	Before (as stated below)		During (as below)	After (as below)
	execution of Sanitary Works.			
	(1838–42.)	(1847–51.)	(1852–61.)	(1862–5.)
Epidemic diseases:—				
Smallpox - all ages	$8\frac{1}{3}$	4	2	$5\frac{2}{3}$
Measles - " -	$9\frac{1}{4}$	$2\frac{3}{4}$	$7\frac{1}{4}$	3
Scarlatina - " -	8	$12\frac{1}{3}$	7	16
Diphtheria - " -	—	—	$0\frac{3}{4}$	$1\frac{1}{2}$
Whooping-cough " -	$4\frac{2}{3}$	4	$4\frac{1}{4}$	$4\frac{1}{2}$
Croup - " -	2	1	$1\frac{1}{3}$	3
Erysipelas - " -	$1\frac{1}{2}$	$1\frac{1}{4}$	1	1
Ague - " -	$0\frac{1}{16}$	$0\frac{1}{50}$	$0\frac{1}{50}$	$0\frac{1}{12}$
Continued fevers " -	$8\frac{3}{4}$	$9\frac{3}{4}$	$7\frac{1}{4}$	10
of which presumably—				
typhus " -	—	1	—	$4\frac{1}{3}$
typhoid, &c. " -	$8\frac{3}{4}$	$8\frac{3}{4}$	$7\frac{1}{4}$	$5\frac{2}{3}$
0–5 - -	?	2·5	2·0	1·8
5 upwards -		6·3	5·2	3·8
Diarrhœa, all ages -	$4\frac{2}{3}$	9	$10\frac{3}{4}$	$8\frac{2}{3}$
0–5 - -	?	6·6	8·6	7·1
5 upwards -	?	2·5	2·2	1·5
Cholera, all ages - -	$0\frac{1}{3}$	(1849 epidemic, $74\frac{2}{3}$)	(1854 epidemic, $11\frac{1}{4}$)	(1866 epidemic, about $1\frac{1}{2}$.)
Dysentery " - -	$0\frac{2}{3}$	$1\frac{1}{2}$	$0\frac{1}{2}$	$0\frac{1}{2}$
Phthisis, all ages and both sexes.	32	26	26	$23\frac{1}{3}$
15–55 males -	?	9·0	10·0	9·2
15–55 females	?	11·2	10·5	9·3
Lung diseases, all ages and both sexes.	37	$37\frac{2}{3}$	$37\frac{2}{3}$	$37\frac{3}{4}$
0–5, both sexes -	?	16·7	17·1	16·8
15–55 males -	?	2·8	2·3	2·6
15–55 females	?	3·4	2·5	2·4
over 55, all ages	?	13·7	14·6	15·1
Brain diseases, all ages and both sexes.	$33\frac{3}{4}$	28	$26\frac{1}{4}$	$28\frac{1}{2}$
0–5, both sexes	?	13·7	10·8	11·2
5–35 " -	?	3·6	3·0	3·2
35–55 " -	?	2·3	3·1	4·2
55 upwards " -	?	8·3	9·3	9·9

Note.—The total death rates have lessened for Clifton and Bristol districts to almost exactly the same degree. If it had been possible to refer to Bristol the deaths occurring in the Bristol workhouse in the Clifton union (that workhouse having lately taken in more of the Bristol paupers), the improvement would be slightly greater in Clifton than in Bristol. But this consideration is of no magnitude.

BRISTOL AND CLIFTON TOGETHER.*—SUMMARIES.

Mean of equal Population from each District.

Mean Rate per 10,000 of each Population yearly.	Before (as below) execution of Sanitary Works.		During (as below)	After (as below)
	11 years, 1838–48.		13 years, 1849–61.	4 years, 1862–5.
Deaths from all causes at all ages - - -	245½		243½	242
[Or, excluding epidemic cholera] - - -	245½		229	242
	1840–42.	1847–51.	1852–61.	1862–5.
Infants under one year, all causes - - -	55½	54	52¾	52
Males -	31·0	30·2	29·6	29·2
Females -	24·6	23·9	23·1	22·7
	1838–42.	1847–51.	1852–61.	1862–65.
Epidemic diseases:—				
Smallpox (all ages)	10½	4½	3	5⅔
Measles - „ -	9⅔	2¼	7⅓	3¼
Scarlatina - „ -	7⅔	12½	7⅓	16
Diphtheria - „ -	—	—	1	2
Whooping-cough „ -	5¾	4⅓	5¼	6
Croup - - „ -	2¼	1¼	1½	3⅓
Erysipelas - „ -	2	1⅔	1	1
Continued fevers „ -	9⅔	11⅓	8	10¼
Of which presumably, typhus, all ages -	—	1⅓	—	3¾
typhoid, &c. „ -	9⅔	10	8	6½
0–5 - -	?	2·6	2·2	2·0
5 upwards	?	7·3	5·8	4·4
Diarrhœa, all ages -	3½	10½	10⅔	9½
0–5 - -	?	7·7	8·6	7·5
5 upwards	?	2·9	2·1	2·0
Cholera (all ages)	—	(1849 epidemic, 82⅓).	(1854 epidemic, 11⅓).	(1866 epidemic, 1½).
Dysentery - „ -	0¾	1¼	0½	0½
Phthisis, all ages and both both sexes.	37	31	29	25¾
15–55 males -	?	11·6	11·6	10·3
15–55 females	?	12·4	11·6	10·3

(*continued.*)

* The *total* death rates only are here calculated on the aggregate of deaths and populations for the two districts. Other death rates are taken at the mean of the two rates prevailing in each district. The greater recent growth of Clifton must not be forgotten in accepting the figures of this table. Consideration of this will show that the method of calculation assimilates the figures of the last column somewhat unduly to the peculiarities of the smaller district of Bristol.

No. 2.
On Results of Works, &c., for promoting Public Health, by Dr. Buchanan.

Bristol and Clifton.

Bristol and Clifton together.—Summaries.—*continued.*

Mean Rate per 10,000 of each Population yearly.	Before (as stated above)		During (as above)	After (as above)
	execution of Sanitary Works.			
Lung diseases, all ages and both sexes.	$41\frac{2}{3}$	$43\frac{3}{5}$	$42\frac{1}{2}$	$41\frac{2}{3}$
0–5, both sexes	?	18·5	18·6	17·2
15–55 { males -	?	4·1 }	3·6 }	3·6 }
15–55 { females -	?	3·7 }	3·0 }	3·0 }
over 55, both sexes	?	16·1	16·3	17·1
Brain diseases, all ages and both sexes.	38	$30\frac{3}{5}$	$28\frac{1}{4}$	$28\frac{1}{4}$
0–5 (both sexes)	?	14·8 }	12·0 }	11·7 }
5–35 " -	?	4·0 }	3·1 }	3·0 }
35–55 " -	?	3·0 }	3·6 }	3·9 }
55 upwards " -	?	8·8 }	9·5 }	9·6 }

Leicester.

Leicester, Borough of.—Population (1861) 68,056.

Previous sanitary condition.

Summary.

From Mr. Ranger's report on the state of this town in 1849, the following passages are extracted. By that report it appears that the town was on an undrained subsoil, that it had a wet surface, and imperfect sewerage on no regular plan; that the courts were wholly neglected and were very filthy; that excreta, dust, and ashes were received into middens, ill drained and irregularly emptied; [numbers of pigs were kept] that water was derived from wells or rain, from a few public pumps, and from the river Soar; that it was variable, bad, and hard; that the town was not generally built too closely, except in some quarters; that there were under 40 common lodging-houses in the usual state that such houses then were. [There was no particular over-crowding of the houses in general.]

Soil.

" The town itself is in the main situated on a saucer of loam, principally stiff clay, overlying a stratum of indurated marl of the new red sandstone; but a portion to the west is built upon sand and gravel."

" The climate of Leicester is moist in its character. The amount of rainfall in 1847 was 27·1, and in 1848 35·1."

" In a report of the sanitary medical officers, Dr. Barclay and Mr. Buck, made in 1847, the following exposition occurs:—

" ' The district most prejudicial to the health of the inhabitants has been the lower part of the parish of St. Margaret, and particularly the streets and courts to the westward of Wharf Street. The older streets at the upper part of the Belgrave Gate, the streets and yards to the northward of the Sanvey Gate, and the district called the Friars, have also furnished a large proportion of cases for medical certificates.

"'The most palpable source of the fever which raged during the autumn has appeared to be the miasma arising from the evaporation of the foul water which inundated certain parts of the town during the summer floods; by which the filth from the larger sewers was carried back into many of the houses, yards, and streets at the lower part of the Belgrave Gate and Archdeacon Lane.'"

"About eight or nine years ago, ague prevailed in Conduit Street, and apparently in the most airy part on the right side going up. It suddenly disappeared shortly after the opening of a drain choked with filth. A new culvert was laid down, and since that period no fever of the same character has prevailed."

Construction.

"The surface of the district about Leicester being irregular, with hills running in a south-west direction, and the aspect of the town being southerly, it derives its ventilation chiefly from the south-east. But although it is thus unfavourably situated, it has the advantage of occupying an unusual extent of ground in proportion to its population, with numerous wide and open streets and thoroughfares varying from 30 to 50 feet, the recent increments being a considerable width.

"The importance of the open construction in the town will be seen, when it is considered that there are 347 courts, alleys, and yards, containing 1,931 houses, generally not exceeding two stories in height. Out of this number 279 are at present unoccupied; the remainder contain 6,185 persons."

Drainage of surface and subsoil.

"Suburban and Surface Drainage.—The condition of the ground, from a want of subdrainage, is exceedingly miserable. The north, east, and west sides are wholly undrained, and the meadows never run dry, whilst the valley, for miles above and below the town, is liable to be flooded after heavy rains, and so tenacious is the soil, that one inch fall of rain produces floods, and a fall of two inches requires 14 days to draw off."

"There is likewise an extensive withy bed immediately in the vicinity of the castle, which is generally under water. The open grounds within the town I found in an equally unsatisfactory state; upon this subject, Mr. Flint, the architect, says, at the back of the various blocks of houses, there is in almost all cases a common yard, whose surface, from the retentive nature of the subsoil, (and where it is of a different character, it is thoroughly inoculated with the liquid refuse and effluvium from privy pits and rainwater), offering an extensive area for the exhalation of noxious effluvia. And in other parts where the property abuts on the streets, and in large portions of the unoccupied land, as well as parts of the yards to the houses which are enclosed by the embankments of the streets and by adjoining higher ground form basins, the rain is received and stagnates. From these basins there is no efficient or regular drainage, and the water can only pass away by the slow process of percolation and evaporation.

"In other parts of the town, as on the south-east side of Great Holmes' Street, the basins dip towards the houses, and the water is consequently conducted into and under the walls, whence they are always saturated. No provision being made for this state of things, excessive dampness is the consequence, the appearance of which are but too evident in almost every quarter of the town."

"The effect of so extensive an undrained subsoil as abounds in and around the town, has been described by the sanitary medical officers, thus:—'The most palpable source of the fever which raged during the autumn has appeared to be the miasma arising from the evaporation of the foul water which inundates the town.'"

"With respect to the general health of the town, they state that its

unfavourable condition, in addition to other causes, arises from the peculiar course which the river takes on the western side of the town, and from the branches derived from it for manufacturing purposes, or for navigation, whereby a large space of low ground is enclosed, which in dry weather is little better than a morass, abounding in decomposing vegetable matter, and the fertile source of malaria."

"In allusion to this subject Dr. Shaw says,—'I have been shocked on entering some of the confined courts and alleys to find the inhabitants living amidst masses of decomposing animal and vegetable materials, totally unconscious of their danger, and even speculating on their heaps of infection, and amassing with anxiety the filth deposited in the neighbouring streets.' There is no local authority vested with power over these courts and alleys."

"Although the streets are generally paved, there is a total absence of proper inclinations for conducting the surface waters off, consequently water hangs upon the surface, and with it every kind of filth, including blood and offal from slaughter-houses, which is swilled down on the surface in front of the dwellings, in one instance to the extent of about a quarter of a mile."

"The most important parts of the town, in respect to the health of the inhabitants, comprising the lanes, courts, and alleys, in common with all quarters inhabited by the working classes, are left uncleansed by the trustees and surveyors, and are dependent on casual scavengers."

Sewerage.

SEWERAGE.—Leicester was provided with an imperfect system of sewerage, concerning which the following particulars are extracted from Mr. Ranger's report:—

"Out of 242 streets and 347 courts, alleys, and yards, there are only 112 with sewers entirely culverted, and no less than 130 either not culverted or but partially so.

"There is neither plan nor regulation of any kind as to depth, size, outlet, or any matter relating to the sewers, the work having been done piecemeal, in some instances by the parish, and in others by the owners of streets sewered. The arrangements for under drainage are of the most defective character; the sewers have been and continue to be laid without any system as to their fall and capacity. In some instances the larger culverts open into smaller, and in others, the water, in consequence of accumulations in them, is pent back, and floods the basements of the houses, depositing a fœtid silt."

"The street sewers are not sufficiently deep to drain the basements of the houses, and in these cases cesspools are sunk down to the springs, and drains laid under the floors, for the purpose of draining the lower parts of the buildings. The principal outfalls of these badly arranged sewers are nine in number, and all situate in the town."

"The length and depth of the sewers is not known, but from the nature of the works described, it is certain that a very large expenditure has been incurred; while from the evidence of the leading medical practitioners of the town, their defective state contributes to the poisonous influence of the surrounding atmosphere, and to the curtailing of human life."

"The canal and the river Soar virtually constitute the main sewers, the latter being exceedingly sluggish, in consequence of the dams for penning up the waters for the use of the several mills, and the former from its very nature and purpose being nearly motionless, the sewerage in each is pooled up; and however the river itself might have answered in its natural state for receiving the filth of the earlier portions of the town, it is now in every way unsuited for the purpose, and the canal equally, if not more so."

"Privies and Cesspools.—Mr. Flint estimates that the number of *uncovered* soilpits receiving the soil, dust, and ashes, amounts to 2,900, and the aggregate surface of the said soilpits exposed, amounts to $1\frac{1}{4}$ acres. The number of privies having ventilated soilpits, with pits for dust and ashes attached to them, amounts to 700."

Privies, &c.

"Many of the bog-hole wells in the central parts of the borough have been dug down to the water-seam to avoid the expense of emptying—a practice which the principal well-digger of the town says he has followed for 30 years and upwards, and in support of the fact, numerous instances are given of the water being infected from the soil-pits, whose depth varies from 5 to 25 feet. Out of the 13,991 houses in the town, Mr. Flint says there are not more than 120 supplied with waterclosets."

Water supply.

"Water Supply (1849).—The present supply of water is variable, and derived from wells, roofage water stored in underground tanks, from one public drawing-place to the market, a few public pumps, and the river Soar.

"The number of houses in 1848 amounted to 13,139; but the number of wells is estimated at 2,800, each furnished with a pump, making on an average, one well to every $4\frac{5}{7}$ houses. The average depth of these wells is 11 yards. The water at present in use is very hard."

"The object of the Waterworks Company was to introduce a purer water into the town; for this purpose they obtained an Act of Parliament in 1847, but from the inability to raise the capital, fixed at 80,000*l*., no steps have since been taken towards prosecuting the work."

"The Company's works are to be formed by constructing an impounding reservoir at a place called Lockey Bridge, near Thornton, about nine miles from the town of Leicester. The reservoir receiving the water of two brooks are called Carr Brook, and the other Thornton Brook, containing 229,000,000 gallons, giving a supply of 2,000,000 per diem. Below the dam, filtering tanks were to have been constructed, and the water is then to flow through a cast-iron main about $9\frac{3}{4}$ miles long to supply the town by gravitation."

Lodgment.

"As a general rule there is but one family to each house. The houses upon an average contain four rooms each, *i.e.* two bedrooms, a room for day occupation, and a kitchen; the dimensions ranging from 12 to 14 feet by 8 and 10 feet; but there are no arrangements for ventilation. There are, however, instances in which overcrowding prevails."

"The common lodging-houses of the town do not exceed 40 in number; but are, from want of proper control, nests of disease and misery, being situated in the worst localities, and generally overcrowded. They are unfortunately made use of by the relieving officer for lodging the casual poor."

Sanitary operations.

Sanitary Work.—It has now to be shown what progress Leicester has made in improving the condition of things above described.

The outfall sewers and works and the supply of water were provided in 1852–1855, but the main sewers were not completed till 1861. During these six years, 1856–61, 30 miles had to be constructed. Since 1861 all the public works are complete, but the connexion of private houses with the sewers is going on up to the date of the present report.

The borough surveyor gives the following account of the outfall and drainage works:—

Description of sewerage works.

"The town of Leicester extends over an area of about 1,000 acres, and contains a population of about 70,000; there are about 400 streets in the town, the total length of which is about 40 miles. Nearly all the streets are sewered to an average depth of about 11 feet, the sewers varying in diameter from 12 to 36 inches,

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Leicester.

the whole of which fall into a main intercepting sewer (varying from 30 to 56 inches in diameter), which traverses the lower districts of the town and conveys the whole of the town sewage into an artificial outfall, formed by the engine well of the sewage works, which are situate on the bank of the river, about a mile from the town. There is also a flood sewer for carrying off storm waters, the outfall of which is into the tail water of the Belgrave mill, about half a mile farther down the river.

"At the sewage works the whole of the sewage from the town (amounting together with spring water, which is admitted into the main sewers at various points, to about 3,000,000 gallons per diem) is raised by steam power into reservoirs placed at a sufficient elevation to allow the purified water to flow off at all times.

"The engines are so constructed that on each stroke a pump is worked, which mixes with the sewage water a certain proportion of cream of lime, which has the effect of causing a rapid and perfect precipitation of all the solid matter which is held in suspension in the sewage, and together with a retarded flow through the reservoirs, produces a perfect deodorization of the effluent water, which passes off in as pure a state as that of ordinary river water.

"The solid matter which is precipitated to the bottom of the reservoirs is worked back by an Archimedian screw, and thence raised by a string of buckets into troughs on the top of the building, from whence it is conveyed by gravitation into reservoirs prepared to receive it, where it lays until the supernatent water drains off, and the solid matter is disposed of as manure.

"Nearly all the streets have a double system of sewers, deep and shallow, the old sewers being left intact throughout the town, receiving, as previous to the construction of the new sewers, all the surface water from the streets, the object being to prevent the heavy *débris* from the streets finding its way into the deep sewers; but junctions are made between the old and the new sewers at various points, and in all cases near the old outfalls, which prevents the foul water from the old sewers finding its way into the river; and none passes by these latter junctions until they are surcharged by heavy rainfall, when the drainage is so diluted as to be perfectly innoxious.

"Another advantage of the double system of sewage is the increased capacity for carrying off rainfall, effectually preventing surface flooding."

Leicester, Jan. 1862.

The sewer inlets are trapped by gullies or D traps. Two dozen factory chimneys carry ventilating shafts up their angle, and these, with many untrapped downspouts afford ventilation to the sewers. The sewers are flushed at their two highest points from a 1,000-gallon tank, filled by a hydrant with the Water Company's water, and the discharge of this being regulated by 12-inch valves into 12-inch pipes. Hose is also used to wash the street gullies, but without great care in flushing the sewers are apt to get a deposit of silt.

The house-drains are 6-inch pipes, constructed separately from each house (not on the block system) to the street sewers. A service box has been always provided for every watercloset, the Company refusing to supply water to closets direct from the mains because of the waste on this plan. The arrangement ensures the supply from the main being shut off during discharge of water.

Effect on subsoil.

The subsoil water was much reduced during the making of the deep sewers, but it is doubtful if it is so much reduced now, as the subsoil receives the water of a large valley, which yields more water than the drains would be expected to carry off. The ordinary shallow wells of 12 feet deep or so into the surface gravel or through it into the surface of the clay, lost all their water at the beginning of the sewer operations. About half the chief wells in the town were then lowered into the clay 30 or 40 to 100 feet deep, when gravel and water-bearing seams were reached. The Company's water replaced the remainder of the well supply.

Water supply improvement.

The waterworks of the Leicester Company take water from 10 miles

off, from the Thornton and Markfield Brooks, and have a storage reservoir of 78 acres, capable of holding nearly six months' supply; thence water gravitates to the service reservoirs, of an acre in extent, two miles from the centre of the town and 90 feet above the level of the centre; this is 30 feet above the highest and 170 feet above the lowest part of the town. Before entering the service reservoir all water is filtered by descent through nine feet of Trent sand. It is delivered to the town by gravitation only; the supply is continuous day and night, some 1,200,000 gallons being delivered daily. More than half the whole number of private houses (about 10,000) are supplied. Factories and the railways are also supplied by the Company. Each house uses about 18 gallons per head per day. The water has about 9° of hardness, and is exposed to no source of organic contamination.

Cleansing.

The public ways and most private courts have been well paved, and are well scavenged; but no regular system of removing ashes and house refuse has been devised.

Sanitary staff.

The Local Board of Health engaged the services of a medical officer of health, of a surveyor and sanitary inspector, and have enforced byelaws for the removal of nuisances, the regulation of common lodging houses, the construction of new streets and buildings, the material and ventilation of drains and waterclosets; the regulation of slaughter-houses, the emptying of privies, and other sanitary matters.

In 1859 a byelaw was passed regulating the space to be allowed to every child in dame schools within the borough.

Present sanitary condition.

The present state of Leicester, deduced from a careful visit to the worst parts as well as to the streets that everybody traverses, may be generally stated to be satisfactory. Although much remains to be set right, there is ample evidence of the town being thoroughly looked after.

The elaborate outfall works succeed in their object of purifying the river from nuisance. The river used to be very foul, showing a frothy surface and all sorts of colours where the sewage was discharged. Now with far more sewage discharged, there is only a little discolouration just at the outlet. The fish have come back too; there were none in the river for two miles down. An exaggerated notion of the agricultural value of the sewage manure has led to a reaction among farmers, who now take away the semisolid manure sparingly at 1*s.* a ton, while the working expenses of its production amount to 3*s.* Chemical estimates fix its value at 12*s.* 9*d.* a ton.

The retention of the old cesspool and ashpit is a drawback to the completeness of the change that has been wrought in Leicester. In the poor neighbourhoods there are far more midden privies than waterclosets. The surveyor does not advise the board to insist upon the conversion of these privies in every case, but in his discretion allows them to be retained, if drained and not ill kept. If the middens are well covered and drained, and have a good quantity of ashes, it is not considered needful to empty them oftener than once a year. There is no sufficiently definite rule about removing ashes and filth. Anybody who pleases may have dust removed and privies emptied by the contractor of the board, but the contractor does not go regular rounds at regular times, so that people frequently save up the contents of their midden until full to overflowing in order to sell the manure to farmers. The town, with its courts, appears generally well scavenged; most private courts are paved, drained, and channelled.

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No source of water, at present in any considerable use, appears to be objectionable. The half or third of the population that does not use the Company's water is in great measure supplied by force pumps from private deep wells. Some few surface wells only are left. The supply of the Company's water is insufficient for the wants of the whole town.

Nuisances removal.

Pigs used to be kept everywhere in large numbers; they have been gradually got rid of by the board of health, and there are now very few in the central parts of the town, but in suburbs there are a good many, and generally they are a nuisance. The allotment system offers a great temptation to pig-keeping. Slaughter-houses are registered, but are a frequent cause of nuisance. There are no public abattoirs.

Even with a considerable accession to population of late years, there is no overcrowding of magnitude in the town only; some half dozen houses are let out in single room tenements. Most houses are tenanted by a single family in each; but quite recently, since trade has got very brisk, and houses cannot be built fast enough, there are many cases of two families in one house. Dirty houses, and those where the medical officer of health finds fever, are visited, limewashed, and purified.

Common lodging-houses number 30 on the register, affording nightly accommodation to 504 persons, and they are generally about two-thirds full. They are well looked after, kept very clean, and every room has a special ventilating aperture.*

Dame schools.

The regulation of dame schools is, so far as the present reporter knows, peculiar to Leicester. The medical officer of health had traced much disease, (particularly of contagious sorts) to these schools, and the following byelaw was therefore made and duly sanctioned :—" Every " room in any house or other building now erected or to be erected, " which shall be used as a day school shall, unless supplied with special " means of ventilation to the satisfaction of the local board, be so " used subject to the following regulations (namely), if the room shall " be less than 8 feet 6 inches in height from the floor to the ceiling, " the space for each scholar shall be 9 superficial feet at the least, and " if such room shall be 8 feet 6 inches or upwards in height, the space " for each scholar shall be 8 superficial feet at the least." The minimum cubic space that seems to be contemplated, without special ventilation, by this rule would thus be 68 cubic feet. As a scholar in a national school with greater advantages of construction is secured 80 cubic feet, the minimum adopted for day schools in Leicester certainly does not err by being too large.

Local defects.

Hitherto mention has been made of what the condition of the main part of the town is, and of the state in which it all would be, if the regulations were everywhere carried out. But a few places, constituting a distinct minority however, are in a much worse condition. Here and there foul surface is found in back yards just undergoing

* Magistrates do not accept the London definition of a common lodging-house (that people of different families sleep in one room), but hold that it is the constant changing of residents which brings the house within the meaning of the Act. In another respect, the practice of Leicester common lodging-houses differs from that of London, and with apparent advantage. If one room in a house is used for tramps the whole house must be registered, and thus it was seen that family rooms in common lodging-houses were kept very tidy and well ventilated, and overcrowding of them was prevented. The inspector professes a difficulty in entering registered houses by night, to see whether tramps are taken in. He finds this even in cases where registration has been refused through the premises not being fit for the purpose, and where he suspects tramps to be still received. It is difficult to understand that the law cannot deal effectually with tramp houses that are too bad to be registered.

transition from a garden, and in such a place a pig, a manure heap, and a filthy common privy may be met with. In a more central part of the town some unpaved courts were found ; a ditch receiving sewage that had not yet been culverted ; a single ashpit, common to two rows of houses, with three stinking privies over it, were samples of other nuisances.

People are growing far more alive to nuisances than they used to be, and complain to the sanitary officers with increasing frequency. Some times unfortunately they are made to suffer for sanitary amendments. A landlord had laid out some 5*s.* in cleansing a two-roomed house, and in consideration of this (as was stated) he had added in permanence 8*d.* to the weekly rent that had been before paid ; and with the recent demand for house room, it was of no use for the tenant to remove.

Occupational fluctuations.

Occupation in Leicester has had several fluctuations in kind and amount during the past 20 years ; the introduction of stocking machines for example having made some great changes. Particularly the four years just preceding the census of 1861 was a time of great industrial depression. Soon before 1861 the shoe trade was introduced, and this has since greatly developed, until at the present time it is believed 20,000 people may be employed in it. The elastic web manufacture too has grown up within the last six or seven years, and some kinds of machine making and a cigar manufactory have sprung up. Allowance has been made for these changes in the estimates of population adopted in analysing the mortality returns, but besides affecting the numbers, the circumstances mentioned may have had a tendency to affect the prevalence of certain kinds of complaints.

Sanitary statistics.

The borough of Leicester being conterminous with a registration district of the Registrar-General, the analysis of the death registers made by him from year to year becomes available for this report, and in this as in other matters all data that had been got out at Somerset House were very liberally put at the disposal of the reporter. Local information has enabled the general statistics to be supplemented in certain points, a correction to be made for the persons belonging to other places who died in the County Lunatic Asylum within the borough, and also (death by death) for the people not belonging to the borough, who died in the infirmary and fever house, so the appended statistics may be taken with much confidence, as representing accurately the facts for Leicester proper.

Deaths per 10,000 of Population, at all Ages. [*See Note.*]	*a*) Before any Sanitary Works. 1845–51. (7 years)	*b*) During construction of main sewer works and supplying water. 1852–5. (4 years)	*c*) During construction of 30 miles of sewer in town. 1856–61. (6 years)	*d*) Since completion of public sanitary works. 1862–4. [*See Note*]. (3 years)
All causes, all ages, both sexes - - - -	264	254	245	263[252]
All causes, under 1 year -	$80\frac{1}{4}$	79	$74\frac{1}{2}$	81
Males -	44·3	43·3	41·8	45·7
Females -	35·9	35·7	32·7	35·2

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Deaths per 10,000 of Population, at all Ages. [*See Note.*]	*a*) Before any Sanitary Works. 1845–51. (7 years)	*b*) During construction of main sewer works and supplying water. 1852–5. (4 years)	*c*) During construction of 30 miles of sewer in town. 1856–61. (6 years)	*d*) Since completion of public sanitary works. 1862–4. [*See Note.*] (3 years)
Epidemic diseases:—				
Smallpox (all ages) -	$7\frac{1}{4}$	$2\frac{1}{2}$	2	$4\frac{2}{3}$
Under 5 -	5·5	2·0	1·2	2·7
Over 5 -	1·7	0·6	0·7	2·0
Measles (all ages)	10	$5\frac{2}{3}$	$8\frac{1}{2}$	$4\frac{1}{2}$
Scarlatina ,, -	3	$8\frac{1}{2}$	$8\frac{2}{3}$	$13\frac{1}{3}$[$8\frac{1}{2}$]
Diphtheria ,, -	0	$0\frac{1}{10}$	$0\frac{1}{5}$	$0\frac{9}{10}$
Whooping-cough ,, -	5	$5\frac{1}{2}$	7	6
Croup ,, -	$2\frac{1}{10}$	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{3}$
Erysipelas ,, -	3	?	?	$1\frac{2}{3}$
Fevers, mostly typhoid, but an occasional typhus, all ages - -	$14\frac{3}{5}$	15	$10\frac{1}{3}$	$7\frac{3}{4}$
Under 5 -	3·6	6·0	4·3	2·9
Over 5 -	11·0	8·9	6·0	4·9
Diarrhœa, all ages -	16	$22\frac{2}{5}$	19	$19\frac{1}{3}$
Under 5 -	14·2	20·2	16·4	17·3
Over 5 -	1·7	2·2	2·6	2·1
Cholera, all ages -	$0\frac{1}{3}$	$0\frac{1}{3}$	$0\frac{1}{4}$	$0\frac{1}{2}$
Dysentery, all ages -	$1\frac{1}{5}$	$1\frac{1}{3}$	$0\frac{1}{2}$	$0\frac{1}{2}$
Phthisis, all ages - -	$43\frac{1}{3}$	34	$25\frac{1}{6}$	$29\frac{1}{4}$
0–5, males -	4·4	3·0	1·7	1·5
,, females -	4·6	1·7	1·3	1·6
15–55, males -	11·6	11·3	8·7	9·4
,, females -	15·7	13·4	10·6	13·2
Lung diseases, all ages -	32	$33\frac{3}{4}$	35	41
0–5, males -	9·3	8·75	9·4	10·3
,, females -	8·2	7·50	7·7	8·8
15–55, males -	2·9	3·2	2·9	3·6
,, females -	2·0	1·9	2·75	2·7
Brain diseases, all ages -	$37\frac{2}{3}$	$31\frac{3}{4}$	$34\frac{2}{3}$	$35\frac{2}{3}$
0–5, males -	13·4	11·5	11·7	11·2
,, females -	11·3	8·0	9·4	10·4
35–55 males -	2·0	1·5	2·1	1·9
,, females -	1·2	0·8	1·8	1·6

NOTE.—Since this table was constructed, the reports of Mr. Moore, Medical Officer of Health, has given materials for including in the last period (*d*) two other years 1865–6. Extension of the period of inquiry to include those years modifies some of the above figures; the principal modifications being indicated in brackets [ ].

The above summary divides the 20 years over which the statistical inquiry extends into four periods (*a*) before the drainage works; (*b*) during the construction of the outfall sewer and the supply of water; (*c*) the six years when the town had received the benefit of those works, but in which street sewers and house-drains were being constructed,

a period coincident with some industrial depression; and (*d*) the time since the town has been pretty much in its present condition, but before the slight overcrowding at present noticeable had begun, and this period is coincident with ample employment in the town.

The total mortality of the four periods has not varied much, but if the third period be taken together with the fourth a certain reduction of total mortality has occurred since the earlier sanitary works. A large mortality in 1863 is the cause of some reincrease in the fourth period.

Infantile deaths (from all cases under one year) were lowest in the third period, but even then were higher than in any town into which these inquiries has been carried. In the three years, 1862–4, they have returned to the same proportionate number as in earlier years.

Smallpox and measles show a lower mean of deaths now than in former years. Scarlatina, on the other hand, has greatly, and whooping-cough has somewhat, increased in fatality. Fevers, which appear to be not exclusively, but in the main, typhoid (typhus, however, having caused no prominent epidemic in the 20 years), were reduced to two-thirds, and then to half their original mortality. Diarrhœa, on the contrary, shows no diminution, but has of late years steadily maintained a little more than its previous rate of mortality. Cholera was not epidemic in Leicester in 1848–9, or 1853–4, but occasional deaths from this cause have been registered from time to time.

Consumption shows a very marked decrease, and the reduction has been pretty uniform for each year within each of the periods. To begin with, $43\frac{1}{3}$ deaths in the 10,000 were annually registered from this cause. In the years while the outfall main sewers of the waterworks were constructed they fell to 34. In the next years, when those works were finished and sewers were being made through the streets, the deaths fell to a mean rate of $25\frac{1}{6}$ annually ; it is to be remembered that there was some less factory work at this period. While since 1861, the consumption mortality has slightly risen again to $29\frac{1}{4}$, this being the period of better house drainage—perhaps, however, of slightly damper subsoil than in the third period,—of comparative cleanliness, and of full occupation. The fluctuations of phthisis mortality have affected both sexes and all ages about similarly, but children proportionately more than adults have improved in their death rate from this cause.

Lung diseases have experienced no subsidence ; on the contrary, their relative prevalence in the four periods is expressed by the figures 32, $33\frac{3}{4}$, 35, and 41. If the changes in mortality from phthisis could be supposed due to changes in occupational circumstances, it would be expected that lung diseases (which are probably not less influenced by such circumstances) would have experienced parallel fluctuations.

MERTHYR TYDFIL.—Population 1861, 52,778.

This is a town where limited improvements have been made, but which is of interest as showing the separate effect of particular measures.

Mr. Rammell inspected Merthyr for the General Board of Health in 1849. In 1854 a report on the then sanitary state of the town was made by Dr. Kay, temporarily appointed an officer of health. These are the chief authorities for statements as to the former condition of the town.

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Sanitary state before recent works.

Situation and soil.

Merthyr is the principal seat of the great iron manufactures of South Wales, including under one general name the town of Merthyr properly so called, and the buildings in the neighbourhood of the Dowlais, Peny-darren, Cyfarthfa, and Plymouth ironworks; it extends in length upwards of three miles. [The area taken for the statistical purposes of this inquiry consists of two registration sub-districts which contain, besides all the foregoing places, Vaynor, a parish of 2,000 inhabitants, lying beyond the limits of Merthyr parish.] "The town is situated in the valley of the Taff, and is placed in an elevated position on the northern edge of the basis of the great Welsh coalfield. Merthyr is 500 and Dowlais 1,000 feet above the level of the sea. The temperature is rather lower than in other places in the neighbourhood in a less elevated position, and a good deal of rain falls. At the bottom of the valley of the Taff is a thick layer of gravel and sand, in some places 50 to 60 feet in thickness, and above this is a light alluvial deposit." But this gravel is absent from Dowlais and other higher lying portions. The gravel is very apt to get waterlogged in its lower parts.

Trade and poverty.

The trade of the town consisted in the four great ironworks, with such other trade as was necessary for supplying the wants of the people engaged in those works. The town was very rapidly growing, but there was no regulation or government of it whatever.

"The residences in the town are almost exclusively tenanted by iron workers. Only 1,117 houses out of upwards of 7,000 are rated to the relief of the poor, and only 383 are rated above 15*l.* All pauper relief is given out of doors.

Houses.

"The houses have generally been built without any system, and, to save space, they have been packed together into courts and alleys having very bad ventilation and no regard whatever to drainage. A large number of them consist of only two rooms, and are very small, many of them not exceeding 8 feet by 10 or 12. In these two-roomed houses there are generally three beds in the upper or sleeping apartment occupied by five or six persons. The four-roomed cottages are generally occupied by puddlers, miners, and colliers, many of whom take in single men as lodgers. Some of the worst description of dwellings are those called the "cellars," near Pont-y-storehouse. They are small two-roomed houses, situated in a dip or hollow between a line of road and a vast cinder heap. In these miserable tenements, which are closely packed together with nothing in front and between them but stagnant pools of liquid and house refuse, it is said that nearly 1,500 living beings are congregated. Many of the tenants take lodgers, mostly vagrants and tramps who swarm into the town."

"The cottages are nearly all built of sandstone, and are nearly all without cellars. With few exceptions they are unprovided with privies or accommodation of any kind for the disposal of excrement or refuse save what the street or the river affords."

Want of drainage.

"Merthyr having sprung up rapidly from a village to a town without any precautions being taken for the removal of the increased masses of filth necessarily produced by an increased population, nor even for the escape of the ordinary surface water; without regulation for the laying out of streets or the building of tenements, and above all having in its population few or none of that class of individuals in easy circumstances who in most other large towns by example or authority in some degree check the wholesale accumulation of nuisances; from all these causes combined, a rural spot of considerable beauty, and with more than the average natural facilities for drainage and water supply, has become transformed into a crowded and filthy manufacturing town."

The town was very deficient in sewerage. There was but one main sewer, receiving soil from 50 houses as well as rain water, deep, and dis-

charging into the Taff river. A draught up this sewer was the cause of serious offence and illness in the course of it. Elsewhere the surface water was not carried off at all. In flatter parts it would stagnate and overflow the floors of kitchens; in houses built on a hill "the liquid "refuse of one row of houses often drains down to the back of another "row situated below it, and often overflows the floor of the lower "houses."

"Houses of a rental over 10*l.* a year are generally provided with privies "and cesspools; the remainder, with very few exceptions, are totally "unprovided with either, the inhabitants making use of chamber utensils, "which they empty into the streets or into the river, or else they relieve "themselves by the walls of houses, and put their children out in the "street in open chairs." Where there were privies they were regarded as "worse than nothing," for upon cleaning them out the common process was to let their contents run over the surface till they reached some other hole or the street gutter, or somehow got washed away.

Want of water.

The water supply of Merthyr was in an amazing condition. Though plenty of water fell, it was carefully hoarded for the ironworks, and that which was available in the streams was so largely befouled that the poorer classes could scarcely get any decent water for domestic purposes. Water for this object was chiefly got from storing rain in casks and butts from a canal supplied by the Taff, and from a fishpond in the course of a mountain brook. "The water in each is eminently impure "and wholly unfitted, even after boiling, for human use, inasmuch as it "contains a quantity of animal and vegetable matter dissolved in it." The water supply for drinking was got from private wells, and supplied by the owners thereof to other persons upon payment of various small rates; or else from springs of water percolating from the river or the canal. The well water was bad in quality, and the more shallow were dry in summer. Water entering them was frequently offensive from the proximity of cesspools. The springs lay at a considerable distance from most houses, and in summer were either wholly dried, or water only trickled from them, so that women had sometimes to wait all night for water; or they travelled from Merthyr to within half a mile of Dowlais to a spring there that was in great repute. Several burial grounds in Merthyr were suspected of contaminating the water of wells near them.

Paving,

Most of the streets had foot pavements, carelessly and irregularly laid by private hands, and they often had no properly prepared roadway, so that many streets were almost impassable for mud. In Dowlais matters were even worse than at Merthyr proper.

and cleansing.

There was no scavenging done except for certain highways, and no public arrangements for the removal of dust and ashes. Dungheaps abounded throughout the town; pigsties and slaughter-houses were some among many nuisances. The town was not lighted.

Crowding.

Little direct mention is made by Mr. Rammell of the density of lodgment in the poor houses; but throughout his reports he implies that the cottages were far too closely tenanted, and the present Officer of Health knows that this was formerly the case both in common lodging-houses and in labourers' cottages.

Inspection in 1854.

In 1854 a very elaborate account of the mortality and sanitary arrangements of Merthyr was prepared for the local board of health by Dr. William Kay, of Clifton, who, confirming all that Mr. Rammell had said as to the want of drainage, necessaries, and water supply in the place, makes a number of valuable deductions from the death registers. He found the infantile mortality to be as great as in Liverpool, here in a semi-rural valley three miles in extent. Where there was no neglect of the babies through their mother's occupation, he pointed out the vast

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prevalence of fevers and epidemic diseases, and insisted on the money value of the life that was thus squandered. He pointed out the vicious construction of houses, the inadequate supply of water, the absence of drainage, and defective ventilation, as the potent causes of the excess in disease and death. On the character of the cottage dwellings Dr. Kay gives some valuable information. They were observed built back to back, and (when on the slope of a hill) one over the other; high ground abutting against their walls, or rising to a level with the roofs; and the most unwholesome dampness was the consequence. Scarcely any of the windows admitted of being opened at the top, some not at all. Dr. Kay adds his testimony to Mr. Rammell's, that the people were by no means naturally uncleanly, and took vast pains in scrubbing and polishing their houses, but that they were compelled to be filthy from the circumstances of their lodgment.

At the time of Dr. Kay's report the local board of health had been in existence two or three years, and in the preceding few months some streets had been formed and channelled; nuisances had been extensively removed, and deposits of ashes and refuse had very manifestly diminished. Some local commencement of drainage had been made. This was just before the cholera epidemic of 1854. The deaths from that outbreak are stated to have been confined to houses without through ventilation, and Dr. Kay urges improvement of this condition as equally essential with means of drainage and water supply.

Sanitary progress by local board.
In cleansing, &c.

It has been premised that sanitary works in Merthyr have not been long in operation, and are not yet complete. But from the beginning that is above recorded by Dr. Kay in 1854 a great deal of progress has every year been made in paving, cleansing, scavenging, and lighting. More of such works would have been done, but that it was considered desirable to defer them till the ground was no longer disturbed by the laying of sewer and water pipes. Where roads are macadamized and channelled they are well scavenged, but elsewhere indifferently. Many private courts are still unpaved and badly channelled. Ashes are removed by contract on the hypothesis that people will put them out for the cart to remove; but in practice they accumulate in many out of the way corners, and until lately fixed ash-bins had not entered into the scheme of the Merthyr board. Still, though these faults are readily seen in the town, there has been a considerable amendment since 1854.

In sewerage.

The sewerage works of Merthyr are only just completed, and have at present only 204 houses connected with them. There is, therefore, no need to give a detailed account of the sewers. They lie deep and receive storm water as well as house drainage, and in the limited area of Merthyr, where surface gravel exists, have no doubt operated to dry that stratum. The arrangements hitherto existing for the disposal of night-soil do not differ materially from the wretched state in which they were found by Mr. Rammell. Many houses and courts are unprovided with any accommodation, and stools are seen about yards and entries. Privies have retained their old foul cesspools, which there is no systematic provision for emptying, and are frequently found full and filthy.

Water supply.

A better progress is to be recorded in respect of water supply. Public waterworks were constituted in 1859–60; the supply was first given in 1861, and every year since has seen it extended. The source of water supply is from the Taff-fechan river, before it receives any contamination from works or dwellings. Here a large storage reservoir for compensation to millowners, and to provide against dry seasons, is constructed. The water is then conveyed by seven miles of iron pipes to a hillside near Merthyr, where filter beds and a service reservoir are formed, holding 36

hours supply. From these Merthyr proper and the lower parts of Dowlais are supplied by gravitation, while the upper parts of Dowlais are supplied by pumping.

The system of supply is that of constant pressure all 24 hours through. Stand pipes with screw taps are placed outside the poorer houses and inside those of better class. There are no cisterns except service boxes to the few waterclosets which exist in the town. The extremes of pressure are from *nil* at the junction of the pumping and the gravitation system to 220 feet in the lower parts of Merthyr; at places in these neighbourhoods a special arrangement is made for the reduction of pressure, or it would amount to some 80 feet beyond this. Nearly 1,000,000 gallons are delivered a day, of which the portion employed for houses and courts is about 15 gallons per head per day. In the absence of waste from closets this will be ample.

In quality the water is good and free from organic matter, though apt to be a little discoloured by peat. It has only 2–3° of hardness.

Houses.

Little or no improvement has been effected in the structural defects of houses that were commented on by Mr. Rammell and Dr. Kay. The way in which a multitude of these houses are built makes great difficulty in any scheme for tinkering them, and it is plain that some resolute and comprehensive alteration of them must be had recourse to. Many rooms built as before described against a hill and half under the surface continue to be occupied.

Changes in Lodgment.

Since 1864, the local board having obtained the services of Dr. Dyke as medical officer of health and two inspectors of nuisances, a great deal of inspection has been done within houses, and overcrowding has been as far as practicable discouraged. Common lodging-houses have been regulated. Twenty-seven are registered, but others are under inspection from time to time, the definition of a common lodging-house not appearing to be precisely settled. It is to be noted that the nuisance of overcrowding in other than common lodging-houses has certainly abated somewhat of late years on account of some little interruption to the staple manufacture, but that again, as trade is reviving, crowding is tending to increase. An average of five people has lately been found in a two-roomed house, and 8 to 10 is the common number in a three or four-roomed house, the family taking in three or four single men to lodge with them. Only in Irish quarters were two families found in one house. The inspection further took cognizance of ventilation—whether there were back doors, and whether windows and sashes opened—and of the state of the house as to cleanliness and surrounding conditions. A beginning is being made to the improvement of interiors, but the effect of any such work on the mortality cannot yet be expected. The spontaneous reduction of overcrowding is a change that was earlier in its operation.

The burial grounds continue open among inhabited parts of Merthyr, and still can sometimes be presumptively connected with disease, especially with certain local outbreaks of fever and cholera in 1865 and 1866.

In brief, then, Merthyr has advanced in its sanitary state in three chief respects:—(1.) Since 1854 by imperfect but extensive nuisance removal and public cleansing. (2.) Since the same time by the regulation of common lodging-houses, and since 1859 by a spontaneous reduction of crowding. (3.) Since 1861 by the introduction of ample good water, and by the services of an officer of health. Other works have either not been undertaken, or have been in operation too short a time to allow of their influence on puble health being measured.

Mortality statistics.

The mortality statistics of Merthyr have been extracted independently, for the purposes of this inquiry, from the death registers of the two

sub-districts; from the total mortality a deduction has been made in respect of persons dying in the workhouse in Lower Merthyr but not belonging to either sub-district. The statistics have been investigated for the 11 years before 1854; for the six next years, during which cleanliness was improved, nuisances removed, and some reduction of crowding occurred; and, thirdly, for the four years 1862–5, during which water supply has been given, and drainage works have been in progress. It must be confessed that if more frequent censuses had been taken, so as to enable the fluctuating population to be better estimated from year to year, the figures might not have turned out the same. But there is no reason to suppose that the general conclusions are vitiated by this defect.

Per 10,000 of total Population yearly.	Before any Works. (11 years, 1845–55.)	During Works of Paving, Inspection, and Nuisance Removal. (6 years, 1856–61.)	After addition of Water Supply and during Main Drainage. (4 years, 1862–5.)
Deaths from all causes, all ages - - - -	332	280	262
Or, omitting epidemic cholera - - -	300	280	262
All causes, under 1 year -	$80\frac{1}{4}$	$74\frac{1}{3}$	61
Males -	44·4	41·3	34·4
Females -	35·8	33·0	26·6
Epidemic diseases:—			
Smallpox - all ages	$10\frac{2}{3}$	$14\frac{2}{3}$	$4\frac{2}{3}$
Measles - " -	$6\frac{3}{4}$	$7\frac{3}{4}$	$6\frac{1}{3}$
Scarlatina - " -	$11\frac{1}{3}$	10	18
Under 5 -	8·5	7·8	12·5
Over 5 -	2·8	2·3	5·6
Diphtheria - all ages	$0\frac{1}{6}$	2	$2\frac{1}{3}$
Whooping-cough " -	$5\frac{1}{3}$	$7\frac{2}{3}$	$4\frac{1}{4}$
Croup - - " -	$4\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{4}$
Erysipelas - " -	$0\frac{2}{3}$	1	$0\frac{2}{3}$
Rheumatic fever " -	$0\frac{1}{4}$	$0\frac{3}{4}$	$0\frac{3}{4}$
Ague - - " -	—	—	—
Continued fevers " -	23	$12\frac{2}{3}$	$9\frac{2}{3}$
Fevers, Typhoid, &c. [excluding what was probably *typhus*], all ages.	$21\frac{1}{3}$	$12\frac{2}{3}$	$8\frac{2}{3}$
Under 5 -	6·9	4·7	1·5
Over 5 -	14·4	7·9	7·2
Diarrhœa, all ages -	$11\frac{1}{2}$	$11\frac{2}{3}$	$6\frac{1}{4}$
Under 5 -	8·5	9·3	4·3
Over 5 -	3·0	2·4	1·9
Cholera, all ages - -	(In 1849, $267\frac{1}{4}$; in 1854, $83\frac{3}{4}$)	—	(In 1866, $20\frac{1}{2}$)
Dysentery " - -	$1\frac{1}{2}$	$0\frac{1}{2}$	$0\frac{1}{3}$

Per 10,000 of total Population yearly.	Before any Works. (11 years, 1845–55.)	During Works of Paving, Inspection, and Nuisance Removal. (6 years, 1856–61.)	After addition of Water supply, and during Main Drainage. (4 years, 1862–5.)
Phthisis, all ages and both sexes.	$38\frac{2}{3}$	41	$34\frac{1}{3}$
Males, 15–55 -	14·4	13·2	11·9
Females, 15–55 -	13·9	14·8	12·4
Lung diseases, all ages and both sexes.	28	38	$32\frac{1}{2}$
0–5, both sexes -	13·7	21·7	16·2
15–55 males -	3·4	3·7	3·3
15–55 females	1·5	2·1	1·4
55 upwards -	8·5	9·5	10·3
Brain diseases, all ages and both sexes.	$45\frac{1}{2}$	43	$49\frac{2}{3}$
0–5, both sexes	37·6	34·5	39·2
5–35 „ -	2·7	3·0	3·8
35–55 „ -	1·9	1·5	2·1
55 upwards „ -	3·3	4·1	4·3

Summary of statistics.

The annual mortality from all causes, at all ages, in the two sub-districts of Merthyr taken together, has been reduced from 332 (or, after exclusion of cholera deaths, from 300) in the 10,000 to 280 in the middle period, and to 262 in the last four years. The mortality of infants under one year has fallen in the same three periods from 80 to 74, and thence to 61, still an enormously high absolute death rate.

In respect of various causes of death, the caution is required that before 1850 a great many deaths (almost wholly those of children) were registered without any statement of their cause, and great numbers of others were set down without medical certificate to "fits" and the like causes.

Bearing this in mind through all that follows, the following statements may be made :—Smallpox has fluctuated much, by far the worst epidemic having occurred in 1858; measles has shown little or no change; scarlatina (here, as in other Welsh towns) has been continuously epidemic and more fatal during several years of the more recent period than before; diphtheria, of which there were probably examples as early as 1850, has been more (but moderately) fatal of late. The last epidemic of whooping cough was somewhat less severe than those that preceded it. So-called "croup" was particularly prevalent in Merthyr about 1850, and on a mean of years has remained pretty stationary throughout the three periods under review. Fevers have been reduced. If a somewhat large excess of deaths from fevers in 1847-8, and a small excess in 1865 be deducted as being presumably true typhus—and probably no other year requires such a correction—the remainder that may be set to the account of endemic typhoid show a notable decrease since means were taken for keeping the town more cleanly. Since 1854 only half the adult deaths from fever have occurred that did occur before that year. In children the registered mortality from "fever" did not subside so rapidly, but has lately come down to a quarter of its earlier amount. There appears to be little difference in the death rate from fever, and any difference

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is almost all in children under five years old, attributable to the mere introduction of the new supply of water. Diarrhœa, on the other hand, has been reduced to a material degree on the average of the last four years as compared with either of the two former periods. Fewer deaths have been registered from "dysentery" lately than in earlier years. The three cholera epidemics have all affected Merthyr severely; per 10,000 of population existing at each time the mortality has been 267 in 1849, 84 in 1854, and $20\frac{1}{2}$ in 1866. It cannot fail to have been seen in the foregoing pages that Merthyr continues to afford peculiar facilities for the propagation of any disease that is liable to be conveyed by the stools.

Consumption was equally fatal in Merthyr before and after the introduction of comparative cleanliness into it in 1854. In the years 1863-5, however, the death rate of phthisis in both sexes and at all ages has fallen, not indeed to a very great, yet to a quite certain extent; this has occurred simultaneously with improvement in water supply and the execution of main sewerage works.

Lung diseases, other than consumption, have not followed the same rule; as registered, they increased a good deal in fatality soon after the earlier operations of the local board, and have in late years declined. But the importance attaching to this fact is much reduced when it is remembered that all the registered increase has been among infants, and that children's lung diseases were rarely stated as a cause of mortality in the earlier times when registration was carelessly done. For a similar reason it would be expected that deaths placed under brain diseases of children would have been much less frequent since medical certificates had become substituted for the statement of parents that their children died in "fits" or from "convulsions." But in fact there is very little reduction of the mortality so classified. Brain diseases above infancy have somewhat increased.

CHELTENHAM.

BOROUGH OF CHELTENHAM.—POPULATION (1861) 39,693.

Even before the time at which registration of deaths commenced, Cheltenham had got certain works of drainage and water supply. The present inquiry will only apply to improvement that has been effected within the last 20 years, and will concern itself with the state of the town before and after the works which, in 1857 and subsequent years, were done by commissioners under a Local Act, and with the influence of these works on the health of the inhabitants.

Condition before sanitary work of 1857.

The following account of Cheltenham, and of its state before the operation of the Improvement Act, is partly compiled from a MS. report of a Health Committee of the Board of Guardians, dated 1846, and kindly placed at my disposal by Dr. Wright; from Mr. Cresy's report to the General Board of Health in 1849; and largely from a very careful pamphlet on the past and present state of Cheltenham, by Dr. E. T. Wilson, physician to the Cheltenham General Hospital:—

"Originally a small straggling village, with an open stream flowing through its main thoroughfare, and known only for its numerous malting-houses, Cheltenham sprang rapidly into notice on the discovery of the mineral waters in 1716, and after the visit of George III. in 1788 its rate of increase had scarcely a parallel in the kingdom.

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"Of late years the increase has gradually declined, but it is still more than double the natural increase of the inhabitants, and during the ten years intervening between the census of 1861 and that of 1851 its increase per cent. was 13·24 as compared with 7·28 of the inland watering places in aggregate.

Site and construction of town.

"Cheltenham occupies a large area of land in an amphitheatre of the Cotteswold Hills, which rise by abrupt escarpments in some places to a height of 1,000 feet or more, and form bold and picturesque features in the landscape. The town is thus sheltered by considerable barriers to the north-east, east, and south-east, whilst it is left exposed to the south-west and south, where the great Vale of the Severn extends uninterruptedly to the Bristol Channel. The 'Basin of Cheltenham,' as it is called, though apparently low, is still raised 195 feet above the level of the sea, and 135 feet above the city of Gloucester.

"On a closer view, the older and denser portions of the town, lying on either side of the High-street, are found to occupy a more or less level plain, from which the ground rises to the north and south, to form the districts of Marle Hill, Montpellier, Lansdown, and Bays Hill.

Natural drainage.

"The natural drainage is conducted by three small streams—1. The Swillett, which runs to the north of the town, and supplies the ornamental waters of Pittville and Marle Hill on its way to join the Avon at Tewkesbury. 2. The Hatherley Brook, which takes a parallel course through the Leckhampton and Hatherley suburbs, on the south. 3. The Chelt, which rises in the Dowdeswell Valley to the south-east, and after flowing through the small village of Charlton Kings, traverses the central portions of the town to join the Severn.

Soil of town, and of vicinity.

"The soil in the neighbourhood of Cheltenham is a sandy loam, lying on a stiff clay, which is very retentive of moisture, and requires much drainage. Within the town, this clay is overlaid for the most part by a stratum of gravel or sand, containing a constant supply of water, which is at times largely given off by evaporation.

"The geological site of the town of Cheltenham is the blue clay of the lower lias, and the overlying sands and gravels are derived from the denudation of the neighbouring rocks, chiefly of the inferior oolite. These sand-beds lie for the most part along the northern and south-eastern portions of the town, and are separated by a wedge-shaped band of clay running more or less along the course of the Chelt, in which gravel-pits occur at uncertain intervals, covered at the surface with a yellow clay of diluvial origin. In the higher grounds of Bays Hill, part of Lansdown, and the whole of Marle Hill, the lias clays are directly at the surface.

"The formations which are developed in the immediate neighbourhood, are the inferior oolite and the lias; the former going to make up the great mass of the Cotteswolds, and stretching diagonally across the country from south-west to north-east; the latter, underlying these beds and resting in turn on the Keuper marl of the new red sandstone, which crops up on the banks of the Severn, at Tewkesbury."—(*Dr. Wilson.*)

Mineral springs.

The mineral springs, for which Cheltenham is celebrated, are derived from the new red sandstone, and contain 60 to 80 grains of solid matter in the pint, with a varying amount of free carbonic acid. The saline ingredients are soda, lime, and magnesia in combination with hydrochloric and sulphuric acids. Some are strongly charged with iron.

Climate.

On a review of what is known of the meteorology of the town, Dr. Wilson concludes:—"Cheltenham, then, as might be expected from its partially sheltered position, enjoys a mild and equable climate, very nearly on a par with London as regards mean temperature, but having a smaller range both monthly and annually. The summer is more than two degrees colder, while the winter is nearly three degrees warmer.

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The prevailing winds are from the south-west; the number of days on which these have been noted during seven years, being nearly double that of any other winds. Comparative shelter is afforded from the east and north-east winds, which are most frequent in spring and after the autumnal equinox."

Early sewerage.

The sewerage of Cheltenham was begun by a company incorporated by Act of Parliament in 1833. Previous to that year the town was almost exclusively drained by cesspools and open ditches, though the commissioners had constructed some few underground sewers. In 1849 Mr. Cresy reported that the commissioners had extremely limited powers of constructing drains, that all existing sewers belonging to them had been vested in the sewer company, and that there were one or two other groups of sewers on private estates. The river Chelt and other streams had been given up to the company as the outfall for their sewage, and ran as filthy stinking, uncovered streams through the centre of the town. The town ditch, the Swillett and Hatherley brooks too, were very offensive. Although the sewage was found thus to pollute the watercourses, only one-ninth of the houses had communication with the company's sewers: of the remainder almost all were provided with "dry-wells" which were great cesspools constructed in the porous subsoil; made of brick without mortar so that all liquid sewage could percolate away. These dry-wells appear from Mr. Cresy's record of his inspection to have caused constant complaint of nuisance, and to have seriously contaminated the water of the wells. Privies appear not to have been supplied in decent numbers to the houses of poor neighbourhoods; instances are quoted of one to five or six or even 10 houses.

Early water supply

A company for the supply of Cheltenham with water was formed in 1824, and expended 61,000*l.* in its operations up 1849. "The water is "derived from several springs on the eastern ridge of the Cotswold (where "the porous strata of the inferior oolite meet the lias clay), and the supply "varies with the seasons. The water is conducted into extensive reser- "voirs $2\frac{3}{4}$ miles from the town, at an elevation of 206 feet above the "highest part to be supplied, and able to contain $2\frac{1}{2}$ million cubic feet. "The number of houses supplied is 2,021, and 146,888 gallons were "daily distributed. The water is supplied for one hour daily, and "stored in cisterns; it has 11 degrees of hardness."

Those who did not take the company's water—the dwellers in upwards of 4,500 houses—were supplied by rain-water tanks and wells sunk to a short depth into the "sand-bed." The water of these wells is stated to have had 58 degrees of hardness.

Paving and cleansing.

The town appears in the main to have been very fairly paved before the date of Mr. Cresy's report. Public roads and streets were well scavenged, but private courts and streets were seldom cleaned. From about a fifth of the houses of the town ashes and refuse were removed by the commissioners, but in the remainder such things were allowed to accumulate till they were sold for a small sum to farmers and others. These accumulations were frequently very offensive in summer.

Lodgment.

Many narrow ill-ventilated and ill-kept courts existed. Common lodging-houses had recently increased in number, and especially during 1847 and 1848 tramps had enormously multiplied. The lodging-houses were dirty and unregulated.

New sanitary works, 1858.

Sewerage.

In 1858, under the powers of the Cheltenham Improvement Act, very considerable additions were made to the sewerage of the town. In 1849 the whole extent of the company's sewers amounted to 5,892 yards, or about $3\frac{1}{3}$ miles. In 1865 the sewers vested in the commissioners made an aggregate of 25 miles, and included several main sewers that had been formed by culverting certain brooks of the town. The greater part of this work was done in the two years 1858–9, when also a very large pro-

portion of the houses were connected. But some works of sewer construction and still more of house connexion have been subsequently done.

The sewerage of Cheltenham is on one single system for surface water and for house drainage. The largest sewer is 5 × 3 feet with smaller mains and submains of brick of various sizes down to the pipes that take off the water of houses. Many of the old drains had been constructed so as to allow of the entrance of subsoil water into their joints and some of them have been retained. Statements made on good authority were found to vary as to whether any of the new sewers were so constructed, but there was no difference of opinion as to the fact that great facilities were given by the sewers to the escape of subsoil water down to their level.

The depth and inclination of the sewers is very various. They keep themselves clean with very little flushing; by filling the manholes a volume of water can be discharged along them. The entrances to the sewers in all yards and waterclosets are trapped, but some inlets (both on the road level and up the sides of houses) are, when so situated as not to cause offence, left open for ventilation.

These sewers drain the greater part of the houses of Cheltenham, but some districts are still supplied with independent private sewers, which are presumed to act efficiently and have their outfalls into the public sewers of the town.

The sewage is intercepted from the river Chelt within the town by two outfall sewers, which convey it to a distance from inhabited houses. Here it is received into tanks, where the floating matter is separated and other parts are removed by the agency of perchloride of iron. The solid matters are mixed with the town ashes, and sell readily for agricultural purposes.* The liquid part of the sewage that has been thus treated is allowed to flow into the Chelt, where it makes no smell or deposit.

Effects of sewerage.

The effect of the new drainage system upon the subsoil water of the town has doubtless been great, especially about the poor and populous district of Saint Paul. Before the works of the commissioners, cellars were frequently flooded, although the works of the old sewers company had dried these for the most part. In making the new sewers, the commissioners had been advised by Dr. Wright, a distinguished geologist and sanitarian of Cheltenham, that the removal of subsoil water was to be kept in view, and their measures appear to have effected a further and notable reduction of the water level where it had been less affected by the previous works. The sewerage of the town has not by any means, however, dried the porous strata of the town to their full depth, as a large part of the water supply of the town is still got from the "sand-bed." Even if the pumps remove much water from this stratum, it cannot be reduced below the level of the river Chelt, and this is still kept up within the town to an artificial height by mill dams.

As regards the removal of excreta by the sewers, it is now almost complete for the whole town. Very few of the old dry-wells remain, and these are in the suburban parts. The great bulk of these were abolished in 1858–9, but some remained, and have been replaced year by year since that time by drains from the closets. Waterclosets in better class houses are supplied with water service, but those in poorer parts have none.

* Latterly at the Hatherley outfall tanks, Mr. Bird's system of making solid manure by the use of sulphated clay has been in operation and is expected to give good results. In 1865 the sewage of the Chelt outfall sewer was employed for irrigation, being distributed by open carriers over 200 acres of land. This was found to work satisfactorily and would have been continued but for some difficulty in paying the sum demanded for the right of carrying the sewage through some intermediate land. The old system of precipitation and filtration has therefore been reverted to.

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House slop and an occasional pailfull of water is thrown down, and they are not even found to be choked. They are all furnished with pans and traps.

Little change in water supply.

The water supply of Cheltenham remains in the hands of the water company, and has undergone no material change since 1849. A very large proportion of the houses are still supplied with water from wells in the sand-bed, and even new houses do not always take the company's water. It is plain that the water supply of the company would not be sufficient for the present requirements of the town. Over a million gallons daily would be needed to render it independent of the sand-bed water, and the company's springs yield scarcely more than a quarter of the requisite amount. Of late years, indeed, the company have not had enough hill water to supply even that limited proportion of the town which depends on their works. Hence during a part of 1866, and until some new source of supply can be determined on, the company have been supplementing their hill water by water derived from the sand-bed under the town, a source that no doubt is now less exposed to contamination than formerly, but which cannot but be a most undesirable source of supply.

Progress in paving and cleansing,

Paving and flagging had been done for the town, it has been said, long before the time to which the present inquiry extends. But the commissioners since their appointment under the Improvement Act have had a very large amount of such work performed in private streets and courts, mainly in 1858–9, but with more or less extension since. On examination of the poorer parts, the paving and channelling of streets and courts was found to be satisfactory. Road cleansing is done by the commissioners' own servants and is sufficiently well performed.

The removal of dust and house refuse is also done by the servants of the commissioners, who undertake this business for the whole town. Either moveable baskets or fixed ashbins are employed; there are facilities for emptying the former almost every day; the fixed conveniences are to be emptied every week.

Pigsties and slaughterhouses have ceased to be a common nuisance in Cheltenham, but there is room for improvement in regard of both.

and in lodgment.

Common lodging-houses are registered and inspected by a medical inspector. They are reported well of, and do not appear to be so much frequented as at the time of Mr. Cresy's report shortly after the Irish invasion of 1847–8. Of poor houses that are not common lodging-houses no systematic inspection has been made, but nuisances in them are dealt with by an inspector. No proceedings have been taken for reducing overcrowding, but this is an evil that probably does not exist in Cheltenham, even as much as it would have existed at the time of Mr. Cresy's report.

Except for inspecting lodging-houses, there is no medical officer in Cheltenham having sanitary functions. But the townspeople owe much to services of this nature that have been continuously and laboriously rendered to them by Dr. Wright, Mr. Rumsey, and Dr. Wilson.

Statistical inquiry.

The mortality statistics of Cheltenham have been investigated for the sub-district, which corresponds exactly to the borough, *i.e*, the area of the jurisdiction of the Local Board of Health. From a return supplied by Dr. Wilson, correction has been made for persons brought from parts outside the borough and dying in the hospital of Cheltenham. Similar correction could not be made for the workhouse, as the death-book of periods before 1853 could not be found. But there can be no material inaccuracy from omitting to consider these deaths, as the deaths among outlying people have only averaged four or five a year, the half of which were in people over 70 years of age. No other source of inaccuracy is known of in the following figures.

Per 10,000 of total Population yearly.	Before (13 years, 1845–57) execution of recent Sanitary Works.	During (2 years, 1858–59) execution of recent Sanitary Works.	After (6 years, 1860–65) execution of recent Sanitary Works.
Deaths from all causes, all ages - - - - -	194	220	185
All causes, under 1 year -	$40\frac{1}{2}$	$42\frac{3}{4}$	37
Males -	22·3	23·4	20.4
Females -	18·1	19·4	16·7
Epidemic diseases:—			
Smallpox, all ages - -	$1\frac{3}{4}$	$6\frac{1}{2}$	2
Measles „ - -	$2\frac{1}{3}$	$6\frac{1}{3}$	$3\frac{3}{4}$
Scarlatina „ - -	$3\frac{1}{3}$	$11\frac{1}{2}$	$2\frac{1}{3}$
Under 5 - -	1·8	7·4	1·7
Over 5 - -	1·5	4·0	0·6
Diphtheria, all ages - -	0	$3\frac{3}{4}$	1
Other acute throat affections, all ages.	$0\frac{2}{3}$	$1\frac{3}{4}$	$0\frac{2}{3}$
Whooping-cough, all ages -	3	$1\frac{3}{4}$	2
Croup - - „ -	1	1	$1\frac{1}{4}$
Erysipelas - „ -	$1\frac{1}{3}$	$1\frac{1}{2}$	$0\frac{3}{4}$
Rheumatic fever „ -	$1\frac{1}{4}$	2	$0\frac{3}{4}$
Ague - - „ -	—	—	—
Continued fevers - -	8	$4\frac{1}{2}$	$4\frac{2}{3}$
Under 5 -	2·0	0·5	0·7
Over 5 -	6·0	3·9	3·5
[Continued fevers, excluding an excess in 1847–8, as probably *typhus*, all ages.]	$7\frac{1}{3}$	$4\frac{1}{2}$	$4\frac{2}{3}$
Diarrhœa, all ages - -	$8\frac{1}{3}$	$7\frac{3}{4}$	7
Under 5 -	6·1	5·8	6·4
Over 5 -	2·2	2·0	1·6
Cholera, all ages - -	(In 1849, no case)	(In 1855, 5 cases 1·3)	(In 1866, 0.)
Dysentery „ - -	$0\frac{1}{3}$	—	$0\frac{1}{3}$
Phthisis, all ages, and both sexes.	$28\frac{3}{4}$	$25\frac{2}{3}$	$21\frac{1}{4}$
Males 15–55 -	10·0	8·4	8·0
Females „ -	12·0	12·1	9·0
Lung diseases: total - -	31	$36\frac{1}{3}$	32
Both sexes, 0–5 -	11·1	13·6	11·0
Males, 15–55 -	2·2	2·6	2·9
Females, „ -	3·0	2·7	2·8
Brain diseases: total - -	28	$31\frac{3}{4}$	$31\frac{2}{3}$
Both sexes, 0–5 -	13·2	12·2	12·6
Males, 35–55 -	2·0	1·9	1·9
Females „ -	1·2	2·5	1·6
Males, 55 upwards -	3·9	6·1	5·7
Females, „ -	4·3	5·6	5·9

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The change in mortality that has followed the change now described in the physical conditions of Cheltenham, is in many respects considerable.

Before 1858, the gross mortality at all ages averaged 194 yearly per 10,000 inhabitants. Since 1859, it has stood at an average of 185 yearly, having sometimes reached but never having exceeded the mean death-rate of the period before 1858. The reduction of mortality from all causes has been slightly greater in children under one year of age than in other persons.

Change in death rates from various diseases.

Comparing periods before with periods after 1858–9, smallpox, scarlatina, and whooping-cough are found to have become somewhat less fatal, while measles has caused an increased mortality. Diphtheria, as a disease of recent introduction, does not need consideration except to note that it has not been absolutely very prevalent here. Rheumatic fever (the statements of doctors confirming the scanty evidence of death registers on this point) has become distinctly less common a disease. Continued fevers have fallen to one half their former amount, and if (deduction being made for probable deaths from typhus) the comparison be restricted to what is probably typhoid, the fall in mortality is still more than a third of the previous amount. Diarrhœa has been a little less fatal than formerly, both in children and adults.

The mortality from consumption at all ages has been reduced from $28\frac{3}{4}$ to $21\frac{1}{4}$, and at ages between 15–55, from 22 to 17 in the 10,000. Probably if allowance could be made for the mortality of invalids who resort to Cheltenham, the change in the death-rate of consumption would be found in much the same proportion, though not exactly represented by these figures. Lung disease and brain diseases appear stationary in the period before and after 1858–9, or show a slight increase.

Cardiff.—Population, 1861 (census), 32,954.

Cardiff.

The area of the borough, lying in three registration sub-districts, is that to which the following account applies. The mortality statistics have been extracted from the registers and supplied to me by Dr. Paine, the medical officer of health of Cardiff.

Mr. Rammell inspected this town for the General Board of Health in 1849, and from his report the following account of its unimproved condition is chiefly taken.

Previous sanitary condition.

"Being the natural outlet for an extensive mineral district, Cardiff "has grown from an insignificant country town to a place of considerable importance in the course of the last century, and shows every sign "of increasing populousness and enterprise." "The number of vessels cleared from the port have risen from 1,934 in 1831 to 7,486 in 1848. In 1840 the Taff railway was opened, and about the same time spacious harbours and docks constructed by the Marquis of Bute were opened."

Growth.

Site.

"The ground upon which the town of Cardiff stands is nearly a dead level, and very little above the ordinary rise of the sea. The highest

* During the execution of the chief works of sewerage and water supply came two years of numerous and severe epidemics, and the total death-rate rose to 220 yearly. The suggestion may properly be made, that epidemic diseases, after their unusual prevalence at that time would be likely (without having undergone any real reduction in their ability to kill) to find fewer victims for some years afterwards. But in fact the period since 1859 has actually witnessed a cycle of each kind of epidemic disease, so that comparison may be made as to fatality between the later and the former cycles.

part of the town is not more than 10 feet above the general level, and this is even 2 feet below the level of high spring tides. The rivers Ely and Taff through the town are prevented by sea walls from flooding the low lying parts adjacent, and such flooding only happens rarely in extraordinary spring tides.

Soil.

" The substratum of the older portion of the town is gravel 6 to " 8 feet deep. Parts nearer the sea have this gravel overlaid by a stiff " black clay. Below the gravel is a hard red marl, which holds up the " water, so that after continuous heavy rains cellars are liable to be " flooded. In summer the bed of gravel is generally quite free from water. At 25 to 30 feet, however, water is very abundant."

Construction.

New houses had been built without any regard to level or uniformity, making the streets very difficult to pave, and both in new and old parts of the town the paving was defective.

There are a great many confined courts, chiefly in the older parts of the town, and 45 were enumerated to Mr. Rammell. " The general description of them may be summed up in a few brief sentences. The ground " in front is neither pitched nor paved, very uneven in surface, no steps " to the doors, and in some instances the floor below the surface of the " court. Most of the houses consist of two rooms one above the other. " There are no outlets except in front, and the locality very confined. No " drainage; very few houses have privies to themselves, and the public privies " are in a filthy condition. No supply of water by pumps or otherwise.

Sewerage.

" Cardiff, for all that relates to refuse drainage, has been left com- " pletely to its fate, unassisted by the commonest aid of science or pru- " dence." But there were drains for removing surface water and slops. These had outfalls into the Bristol Channel on either side of the Bute Docks. The drains were mostly square channels with a succession of catch-pits in which, and in the drains, matters were constantly depositing. These sewers were not laid deep enough to drain the cellars. No privy was allowed to communicate with them. In many parts, however, there was total absence of any sort of drainage.

There was a general want of privy accommodation, hundreds of houses having none at all; and excreta were deposited, and chamber-pots emptied, over gratings or upon dunghills in the back streets. The streets were in a very filthy state from this cause. Such privies as did exist in the poor quarters were almost all full and offensive.

Water supply.

" The public water supply for ordinary domestic purposes is obtained from the river Taff, from the canal, or from a few pumps in different parts of the town, some of which are fed from the canal and others from wells sunk into the gravel and marl strata of the upper part of the town. The supply is insufficient and uncertain, and the quality deteriorated by the filtrations necessarily taking place in an ill-drained soil."

" There are private pumps in some of the houses, but their water is often " rendered unfit for drinking by sewage or cesspool percolation. Even the " deeper wells of 25 to 30 feet deep become contaminated from cesspools." The " public pump " at Crockherbtown was sent to from great distances for drinking water, but its yield was inconstant and its water hard.

Cleansing.

After what has been said of the heaps of filth in the streets it need hardly be added that scavenging and ash removal was very inefficiently performed.

Overcrowding.

Very serious overcrowding existed in Cardiff in 1849. Nothing " can be worse," Mr. Rammell says, " than the house accommoda- " tion provided for the labouring classes and the poor in this town. " The overcrowding is fearful, beyond anything of the kind I have ever " known of," and he states there were instances of four or five families in one small two-roomed house. In Stanley Street, the least number of persons met with in such a house was eight. Not only were bedsteads packed as close together as was possible, but people actually slept under as

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well as upon them. This excessive overcrowding had been brought by an influx of Irish, partly coming for the sake of work on the docks, partly brought "as ballast," and often bringing fever with them.

Sanitary works.

Water supply.

The earliest sanitary measure adopted in Cardiff was the supply of water to the town. A company was formed for this purpose in 1850, and in March 1852, the town was first partially supplied. Dr. Paine in his first annual report on the year 1853 considered that no town had had a less proportionate water supply, inadequate in quantity and much of it bad in quality; and that, though the company had materially lessened the extent of the evil, many houses and courts inhabited by the working class were still unsupplied. But at the beginning of 1856, he reports that the water supply was good and ample, the company supplying 2,700 houses in poor as well as better class localities. And since that date, all or nearly all the remaining houses have been provided with the company's water, though until the autumn of 1866, some few got their supply from wells. The water of the company is derived from the river Ely, three miles off Cardiff, at a point where no drainage affects the stream. It is pumped into reservoirs and filtered through sand. During a part of the year, water from certain hill streams enters the same reservoir by gravitation, and for the last two years this has formed a large portion of the entire supply. It is delivered on the constant system by day and night at a pressure of 75 feet and about 30 gallons per head per day is given; a large amount is used for public purposes, which is not included in this statement. There is not much waste, closets not being supplied unless they have cisterns, and poor closets not having water laid on to them. The ordinary screw tap is in use. The quality of the water appears to be good, but sometimes it is a little earthy and turbid: there is reason to believe that of late years the river Ely has furnished a less pure quality of water. The river water has 7° and the mountain water 11 of hardness.

Sewerage.

The sewerage of Cardiff was begun in 1854 or 1855 and completed in 1857. In these three years 42,000*l.* were expended. The sewers take off house drainage and surface water by the same system. Their average depth below the surface is 15 feet, 12 to 20 feet being the extremes. All but the house drains are of brick, the main sewer being 6 by 4 feet, the submains 4 by 2 feet 9 inches, and a very large amount of the next size 3 by 2 feet. Extensions of the sewer system have been made into new streets, generally before houses were built along them. The sewers deposit very little soil, but much sand; they are flushed by the surplus water from a channel which feeds the docks; 1,000,000 to 2,000,000 gallons daily running through the main sewers. For parts where this is not available a special flushing reservoir is constructed. The outfall of the sewers is into the sea a quarter of a mile to the east of the docks, at mid-tide level. At flood-tide sewage backs up along the mains and fills the street sewers, occasionally even flooding the cellars of lower part of the town.* The sewers are ventilated by eight mill chimneys and by that of the gasworks, and there are also many ventilating apertures in the centres of streets, which it has been attempted without much success to protect by charcoal bones. In private courts and near houses all entrances to the sewers are trapped, commonly by iron D traps.

Effect of sewers.

The effect of these sewers in lowering the water of the subsoil has been very considerable, the water used to stand in the wells to a height of nine feet below the surface, now all wells are dried that do not go down 15 to 20 feet into the sand bed. Where, in lower districts, the subsoil is clay,

* A scheme is in contemplation for preventing this occurrence by the construction of a storage reservoir at the outfall during storms and high tides. This will be a most important measure from a health point of view.

of course there has been no material change in dryness of soil, but even here the removal of copious stagnant surface water and latterly the filling up of an old river bed has added much to dryness.

The effect of the drainage system in removing night soil and house slops is nearly universal. Many more closets have been constructed; all are supplied with pan and trap, but no fixed water supply; they are kept sufficiently pervious and clean.

The streets of Cardiff were partly paved in 1851 by streets commissioners. Private streets and courts were paved soon after the establishment of the local board and were all completed in 1858; now all, even down to the poorest courts, are now well scavenged, and there is no trace of the condition of matters in this respect described by Mr. Rammell.

Paving and cleansing.

Removal of dust and solid refuse from the town is now quite efficiently done. There are no such things as fixed ash-bins, but all house waste is stored in boxes and put out in the street for the contractors to remove. This is done with regularity in every street every day before noon.

Improved lodgment.

But it is, perhaps, in the lodgment of the people that the authorities of Cardiff have, with the advice and vigorous assistance of Dr. Paine, made the most remarkable progress. They had to deal with a town which, up to 1857, was increasing at a more rapid rate than almost any town in the kingdom, and the difficulties of dealing with the question of lodgment for the poor was of a magnitude that has completely baffled the efforts of less resolute persons elsewhere. Rents were high, and any sort of accommodation was eagerly accepted by the poorer classes, many of them Irish, who knew nothing of sanitary wants, but cared much for the price at which they got their lodging. Dr. Paine began with inspection of sublet houses, as well as by the registration of common lodging-houses. In 1855 his inspector made 14,214 visits in the day-time, and 9816 visits in the night to nearly a thousand houses in which more than two families resided. The landlord was found to sublet the house into rooms, the tenant of the rooms sublet the beds. "The extent to which this reaches can hardly be conceived," and Dr. Paine gives some strong instances in point. The result of the inspection was to leave the houses at the end of the year more cleanly, better ventilated, and less crowded. Three or four hundred common lodging-houses were brought under regulation. To some extent the prevention of overcrowding in the borough stimulated the growth of new houses in the suburbs, but there is evidence that the total population within the borough still went on increasing during the operation of these measures.

But for the last four or five years Dr. Paine has gone farther than this. He found difficulties in the definition of a common lodging-house, and gave up working under the special act. He then took the overcrowding clause of the Nuisance Removal Act as the basis of his work, and with the assent of his Board and the active co-operation of the magistrates he devised a plan for regulating all sub-let houses. He has kept a register of every such house, with the number of people that they may properly hold, and he has insisted that, whatever the house, no more persons shall sleep in it than the registered number. In poor streets he took in even tradesmen's houses (with rents of 30*l.* a year paid quarterly) when there appeared to be occasion, and by constant inspection and occasional penalties he has made his regulations obeyed. In 1866, under the same Act, he has even gone further, and will not allow in the borough any bed to be on the ground floor of any house, and will not allow any room to be let for sleeping that is also occupied during the day. This applies to all sublet houses, and is daily enforced by the inspector (in anticipation of any rules that might possibly have been made under the Sanitary Act, 1866), with the effect of keeping even the poorest houses decent; and of obtaining, except in a small minority of such houses, strict

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obedience to the regulations. The scale of space adopted is commonly 400 cubic feet for every person, adult or child.

Upon an inspection of Cardiff, nothing could be more striking than the contrast between the condition of things described by Mr. Rammell in 1849, and that seen in 1866. The population now increases almost wholly in the suburbs, partly as the result of Dr. Paine's exertions; but the possibility of indefinite centrifugal extension of the town has conversely facilitated much the action he has taken. It was quite wonderful to see Irish quarters that were formerly tenanted in the thickest and most indecent way, still indeed occupied by very poor barefooted dirty people, but the houses fairly clean and tidy, uncrowded, with windows open, some little comforts beginning to appear within, and every needful convenience readily accessible outside.

Mortality statistics.

For an examination of the death registers in the borough of Cardiff I am indebted to Dr. Paine, whose published reports give information as to causes of death within the exact limits of the borough. Dr. Paine has been so good as to extend this examination back beyond the period of his published reports so as to comprise a period of 20 years, eight of which were before, four during and eight after the completion of the chief sanitary operations of the town.

Per 10,000 of total Population yearly.	Before (8 years, 1847–54)	During (4 years, 1855–8)	After (8 years, 1859–66)
	execution of Sanitary Works.		
Deaths from all causes, at all ages - - - - - -	332	219	226
Or, excluding epidemic cholera	297	219	224
(All causes, under 1 year) -	?	?	?
Total of atrophy, debility, tabes, and teething, (and see *convulsions*, infra).	28	$20\frac{3}{4}$	$25\frac{3}{4}$
Epidemic diseases :—			
Smallpox - - all ages	$12\frac{1}{4}$	11	$2\frac{3}{4}$
Measles - - „ -	$8\frac{1}{3}$	4	$6\frac{1}{3}$
Scarlatina - - „ -	$7\frac{1}{4}$	$4\frac{2}{3}$	$13\frac{2}{3}$
Diphtheria - - „ -	—	$0\frac{1}{3}$	2
Whooping-cough - „ -	$6\frac{1}{3}$	$6\frac{1}{3}$	6
Croup - - „ -	$3\frac{2}{3}$	4	$3\frac{2}{3}$
Erysipelas - - „ -	$1\frac{3}{4}$	$0\frac{2}{3}$	$0\frac{1}{2}$
Rheumatic fever - „ -	$0\frac{1}{3}$	$0\frac{2}{3}$	$0\frac{1}{3}$
Ague - - - „ -	$0\frac{1}{10}$	$0\frac{4}{10}$	—
Continued fevers - „ -	$21\frac{1}{3}$	$4\frac{1}{2}$	$10\frac{1}{2}$
Typhoid fever, &c. [excluding an excess in 1847 as probably *typhus*,] all ages.	$17\frac{1}{2}$	$4\frac{1}{2}$	$10\frac{1}{2}$
Diarrhœa and dysentery } all ages -	$17\frac{1}{4}$	$5\frac{2}{3}$	$4\frac{1}{2}$
Cholera, all ages - -	(In 1849, 208)	(In 1864, 66)	(In 1866, $15\frac{1}{2}$)
Phthisis, all ages and both sexes	$34\frac{3}{4}$	$25\frac{2}{3}$	$28\frac{2}{3}$

Per 10,000 of total Population yearly.	Before (8 years, 1847–54) execution of Sanitary Works.	During (4 years, 1855–8) execution of Sanitary Works.	After (8 years, 1859–66) execution of Sanitary Works.
Lung diseases, all ages and both sexes.	$31\frac{1}{4}$	$28\frac{3}{4}$	30
Brain diseases:—All ages and both sexes.	$44\frac{1}{4}$	$40\frac{2}{3}$	$30\frac{1}{4}$
Convulsions and hydrocephalus.	34·1	29·8	20·9
Other brain diseases - -	10·1	10·7	9·4

A notable improvement in the health of Cardiff dates from the period of the earlier sanitary works. In the years 1847–54, examined before the chief improvement began, there are indeed included several whose death-rate was peculiarly raised, that of 1847 by typhus, that of 1849 largely by cholera, and that of 1854 also by cholera to a less degree. But even with deduction of every death from these epidemics the rate of mortality before 1855 was over 29 in the thousand. Since sanitary works it has averaged 22 in the thousand only. No special inquiry into the ages at death has been made, but by massing together such causes as 'atrophy,' 'convulsions,' and 'teething,' it may be inferred that young children have profited about as much as adults by the sanitary work of the town. The rate of death from all such causes has fallen from 62 to $46\frac{1}{2}$ in the 10,000 of total population yearly.*

Of the more contagious epidemics smallpox has declined notably, and measles to a distinct amount, whooping-cough has been almost stationary; while from scarlet fever the mortality has almost doubled of late years.

Fevers of all kinds have become reduced to half their previous fatality, and during the years when sanitary works were in progress they were reduced to even a quarter of their earlier amount. This statement requires correction if the ordinary endemic typhoid alone be considered, for in 1849 Cardiff like other towns had its fever death-rate artificially raised by the importation of Irish typhus. Deducting the deaths of that year, the previous fever death-rate was larger than it has been since the sanitary operations, in the proportion of $17\frac{1}{2}$ to $10\frac{1}{2}$ on the average of years.

Diarrhœa with dysentery has been less fatal since 1858 than it was before 1855, in the proportion of $17\frac{1}{4}$ to $4\frac{1}{2}$. Its high mortality in the early period probably comes from the inclusion of epidemic dysentery in 1847–9. Diarhœa began to decline as soon as the works of sewerage were begun, and when the supply of water became abundant.

The cholera epidemic of 1849 fell with great force on Cardiff, the

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* The deaths of Cardiff were, in 1847-9, greatly in excess of births. Between 1849 and the commencement of sanitary works in 1855 there was a slight excess only (some 80 a year) on the side of births, but since 1855 the excess of births over deaths has never been less than 385 each year, and has averaged 427 a year. To some small extent the difference is accounted for by an improvement in the practice of registering births since 1856.

* I need not refer here specially to the fact that scarlet fever has been very unusually prevalent over England in the last six years, but it is to be noted that this epidemic wave of scarlatina broke with special force over South Wales. See returns for Merthyr and Newport.

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town being then in the state described by Mr. Rammell to the Board of Health. It then caused 208 deaths to every 10,000 people. In 1854, before the sewerage works, but when early attempts had been made to deal with nuisances, and when a better though incomplete water supply had been given, the borough lost 66 per 10,000. In 1866, when a very great portion has been done of what public measures can contrive to do for health, the mortality has been 15½. This undoubtedly shows great progress; but there remains, even when the many facilities afforded by the port for cholera importation and the larger cholera mortality in adjacent ports are taken into account, a number of deaths large enough to demand incessant and increasing vigilance against those uncleanly conditions upon which cholera of all other diseases, loves to fasten itself.

The mortality in Cardiff from consumption has not been investigated by Dr. Paine with reference to its prevalence at various ages, but in total fatality a considerable decrease, amounting to 17 per cent. of its former rate of prevalence, has been experienced in the town. The total of lung diseases other than consumption has not altered to any noteworthy degree. And brain diseases, except in the considerable section of diseases so registered that stand under convulsions and hydrocephalus, have not undergone any remarkable change. Diseases registered under convulsions and the like titles have been far less fatal of late years than formerly.

Hospital ship.

An account of the sanitary progress of Cardiff cannot well be concluded without mention of a benefit that has been prepared for future years by the recent establishment of a "hospital ship." A large vessel of war has been given to the port by Government, and has been fitted up with every requisite for the treatment of nearly 100 patients. This hospital will not only be an invaluable boon to sick sailors, but will prevent the importation of much disease into the common lodging-houses of the town. Dr. Paine has the credit of originating this scheme, and he has found plenty of public spirit to enable him to bring it to a successful and most practical issue.

CROYDON.

Parish of CROYDON.—Population, 1851, 20,355; 1861, 30,229.

Previous sanitary condition.

In 1849 the condition of this town was made the subject of inquiry by Mr. Ranger, of the General Board of Health, from whose report the more salient points are extracted.

Site.

" The town lies on the east and west sides of a valley with the river " Wandle in the bottom." Receiving several tributaries and supplying several ditches, the course of the river is towards Waddon, but " it is " pent back for the purpose of supplying a mill situate about 60 yards " from Croydon church, and is again pent back at Waddon to form " another millhead there. In its way through the Old Town and " towards the church it is the recipient of waters from Scarbrook and " Laud's ponds. The dam near the church, with that of the Waddon " mill, throw the waters back on the lower part of the town; so that " when the water of the Bourne at certain irregular periods flows with " increased volume, some of the streets are covered with water." From the time of Henry VIII. the site of the town had been known as damp

and unwholesome. "The soils on which the town stands are strata "intervening between the London clay on the north and the chalk on "the south side of the town, and consists of regular beds of sand with "occasional seams of clay." "The rainfall in 1847 was 15·65 inches, "and in 1848 amounted to 28·84 inches."

Soil.

Construction.

"The several courts are so arranged as to preclude a free current of "air through any part of them," but courts did not form a very large portion of the plan of the town.

Drainage.

"The town itself is entirely devoid of under drainage, and is "therefore dependent on a surface drainage, which is a source of "unhealthy exhalations." "The rivulet that enters the lower end "passes in an open channel in one of the axis lines of the town, "collecting in its course a considerable amount of filth." "In this "locality is an open, elongated, stagnant cesspool, full of putrefying "sewage matters." "Those enormous reservoirs for the reception of "filth, called Laud's and Scarbrook ponds have been used from time "immemorial to receive the sullage of the town as well as that from "slaughter-houses and private dwellings. The stench from Laud's "pond is very bad, and in the summer time unbearable. Scarbrook "pond receives the sullage from the middle part of High Street." "On Croydon common, where the habitations consist principally of "cottages, the owners have been permitted to lay drains and convey "the overflow of sullage into the ditches close by the side of the "different footpaths, and as a consequence this, though the highest "part of the parish, has been rendered the most unhealthy." "The "inhabitants throw their sullage into the public drains in the street, not "intended for that purpose, consequently the streets are constantly in "a filthy state, and the drains still more so." "The inhabitants in "many instances have no means of disposing of the sullage from their "ill-arranged habitations other than the public thoroughfares." "The "only drains hitherto constructed have been for carrying off surface "water from the roads and not for house drainage." But "for "want of a proper system of drainage the best of the roads are "charged with water, and when water is present it is quite impossible "to keep the roads *down*, especially in wet weather. The water "hangs upon the surface, facilitates the deposit of filth, which leads to "a further retention of moisture." "The subsoil of the old church-"yard is gravel; the water, however, stood within two feet of the old "vicarage garden."

"There are not more than 300 waterclosets in the whole parish, "the residue consisting of common privies. The average of privies "among the poorer classes is not above one to three houses, many of "the houses containing several families." Considerable groups of houses "destitute of every accommodation." In one locality "the "privies are all open, overhanging the watercourse;" in another, "the "soil from the privies oozes into many of the houses below without a "remedy." "In many of the better class of houses in High Street "the privies are situate in the lower apartments, some in cellars, others "leading into the kitchens, with no means of getting rid of the soil "except by bringing it through the house." The cesspools of Croydon were independent of ashpits. There was no systematic method of emptying the cesspools or of removing house refuse. What went into the public ponds and ditches found its way into the river, or was cleared out at irregular times.

Water supply.

"The town is furnished by nature with an inexhaustible supply of "water, but the springs are nearly all contaminated." "The whole supply is from shallow wells, and the water is very often tainted by cesspools sunk in the porous soil close to the well." "Out of 1,550 houses 755

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" are not supplied at all; 275 complain that the water is not good and " the supply insufficient."

In large parts of the town the roads were reported habitually wet and foul; many of the courts and alleys were unpaved. " Large dung-" heaps abound in the town, the liquid frequently permeating the walls " of the adjoining dwellings."

" In the habitations of the poorer class numerous instances of over-" crowding presented themselves," houses being frequently sublet to several families.

Nuisances.

Sanitary works, account of.

Sanitary operations were begun in Croydon in 1850, and by the end of 1853 the chief of them had approached completion. The following account of their nature is mainly extracted from pamphlets by Dr. Westall and Dr. Carpenter, two medical men who have been in the van of sanitary progress in the town:—

Waterworks.

" The work comprised an entirely new water supply from a deep well, the water being pumped up into a large covered reservoir holding 900,000 gallons, at a height of 142 feet to ensure constant service, and to reach the highest houses; and a thorough system of sewerage by glazed earthenware pipes, both for sewers and house-service, by back drainage."

" The completion of each of these undertakings involved the board in great difficulties. After two years of litigation with millowners, and at a cost of 5,000*l.* to the parish, it was finally decided in the House of Lords on July 29th, 1859:—1. 'That the underground water in the land belongs to the owner of the ground;' and 2. 'That he may drain that water out of his land, in any direction that he finds the best, for his, or its enjoyment or cultivation.'"

" The water supply of Croydon leaves nothing to be desired on that head. There is a constant supply of the purest quality; and if anything be lost in its comparative hardness, it is fully compensated for by its freshness. The supply was calculated at 11 gallons per head daily; it now ranges from 46 to 56 gallons."

The supply of water is on the continuous system, no water receptacles being used in the town, and is supplied 6 a.m. to 11 p.m. It has been augmented within the past two years to keep pace with the growth of the parish, and two artesian wells are now at work. Only some outlying parts of the parish at South Norwood have any deficiency in regard of water, the supply there coming from the Lambeth company being dear and scanty.

Sewerage works.

" Our difficulties with the sewerage and drainage were even more serious, involving, as they did for a time, an increased mortality from zymotic diseases."

" Before one step could be taken, a mill, which had been erected less than 40 years, within 300 yards of the church, whereby the water-line of the town was raised $7\frac{1}{2}$ feet, had to be purchased and removed, and a large culvert formed, to conduct the Bourne and storm waters through the lower parts of the town. As no power existed at this time to take the sewage matter beyond the limits of the parish, good as the outfall may be, the intervening distance was too short to admit of any sufficient or effectual means of deodorization. All attempts to send the strained water into the river, even in a state of comparative purity, were unavailing."

" Every house is connected with the sewers by glazed earthen socket-pipes, the larger sewers being of brickwork in cement, discharging at five different outfalls. Every house, or series of houses, is ventilated by the rainwater stack-pipes, or by upright pipes placed outside the houses. All the drains and sewers are flushed at frequent intervals."

The inlets to the said drains are all trapped, and to some extent

ventilated by rainspouts and by special pipes carried above the houses. Defects in these arrangements will be immediately mentioned when the fever of Croydon comes under consideration.

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"The filthy watercourses extending through the old town and other places have been removed by means of an enormous culvert, extending from near the Stock market to the present head of the Wandle; this culvert has diverted the surface streams, has drained many of the shallow wells, and acted as an agent in draining a great part of the Old Town."

"The removal of the mill-dam which existed below St. John's church, at once caused a fall in the water-line of the district to 7 feet below the surface; the graveyard of St. John's church used to have the water within two feet of the surface of the ground, sometimes even less than that before the dam was removed."

"The several ponds called Laud's, Scarbrook, and New Lane, and many other smaller deposits of filth, have been drained and filled up."

"Nearly 2,600 cesspools of the town have been destroyed."

The poorer parts of the town as well as the better houses are now supplied with waterclosets, with water from the mains; they sometimes get out of order, but in the main are clean and well kept.

Disposal of sewage.

The chief of these works, it has been said, were finished in 1853, and the end of 1856 may be taken as the date of their entire completion. But at that time temporary measures of dealing with the town sewage by deodorization were in action; these have for the last four or five years been superseded by a system of irrigation at each outfall. At Beddington, 1,000,000 gallons a-day have now been employed for some years to irrigate 310 acres of land. There are no complaints of injury to the neighbourhood, and the agricultural value of the land has much increased, the sewage being productive of equally good results in dry and in wet weather. The sewage, after passing over the land, contains just 1 grain of total impurity more than the water of the Croydon waterworks—22 and 23 grains to the gallon; here the soil is porous gravel. At a second outfall at Thornton heath, 250,000 gallons daily are used on 20 acres of land where grass and market produce are grown, and for most crops it is found to give remarkably favourable results; here again the soil is gravel. At a third outfall in Beckenham parish 37 acres of stiff clay soil are irrigated, and the largest and healthiest crops of all to which the sewage is applied are got from this clay soil, a circumstance that was not expected, while the purity of the effluent water is almost absolute. A fourth outfall goes into the metropolitan sewers.

Cleansing and nuisance removal.

"The slaughter-houses of the town have been placed under inspec-
" tion," "and others have been erected by the board outside the town."
" The courts and yards are habitually cleansed, whilst there has been a
" considerable improvement in the pavements of the town, although
" there is still room for further attention in this direction."

"A thorough system of scavenging is carried out."

"An excellent code of byelaws has been framed by the Secretary of State, in which are stringent regulations referring to cottage buildings; more especially applying to their ventilation, lighting, and the area of the rooms."

Nuisances are now removed with considerable regularity, but house refuse has not been got rid of completely, and lately the board has performed this duty themselves.

Overcrowding appears to have been reduced, since the average number of persons per house in certain districts examined by Dr. Westall was, in 1851, $6\frac{1}{3}$; in 1861, $5\frac{3}{4}$; and in 1865, only $5\frac{1}{2}$. Some old houses have been pulled down.

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Growth of town.

The growth of Croydon by the building of suburban villas has been very rapid, and is an element to be considered in examining death rates. One reason for this fact is the preference given to the special district of Croydon by builders. Property known to be drained into the Croydon system is more sought after than other property situated beyond the parish, and the value of land and houses is thus enhanced.

Sanitary statistics.

The parish of Croydon is the district of the local board of health, and is taken on the basis of statistical inquiry. The profit of sanitary measures would, of course, be chiefly experienced in the town proper, to which, if practicable, the inquiry should have been confined. The addition of a population about half as large again as that of the town itself and in which there was not so great room for amendment, makes the change appear less considerable than it would otherwise be. Tables, carefully compiled by Dr. Westall from the register of death, have afforded the materials for the numbers accompanying the present report, of which the following is a summary :—

Per 10,000 of total Population yearly.	Before (6 years, 1845–50.)	During (6 years, 1851–7.) First 3.	Second 3.	After (8 years 1857–64)
	execution of Sanitary Works.			
Deaths from all causes at all ages.	237	229	221	190
All causes, under 2 years; both sexes.	51	56	61	56
Epidemic diseases :—				
Smallpox (all ages) -	$4\frac{1}{2}$	$0\frac{2}{3}$	$4\frac{1}{3}$	$2\frac{1}{4}$
Measles ,, -	8	4	$6\frac{2}{3}$	3
Scarlatina ,, -	$8\frac{2}{3}$	10	$4\frac{1}{4}$	7
Whooping-cough ,, -	$8\frac{3}{4}$	7	7	$5\frac{1}{2}$
Erysipelas ,, -	$2\frac{1}{2}$	$2\frac{3}{4}$	2	$1\frac{3}{4}$
Continued fevers ,, -	$16\frac{1}{2}$	19	$11\frac{1}{2}$	$5\frac{1}{2}$
[Excluding half the excess of 1848–9 as probably typhus] typhoid.	15	19*	$11\frac{1}{2}$	$5\frac{1}{2}$
Diarrhœa - - -	10	14	9	7
Cholera - - -	[Epidemic 1849 27]	—	[Epidemic 1854, 21]	—
Dysentery - - -	1	1	1	$0\frac{1}{4}$
Phthisis and lung diseases together (all ages and both sexes).	$59\frac{1}{2}$ or w. influenza 61	53	53	49
Convulsions, infantile - -	$6\frac{1}{2}$	8	$7\frac{1}{2}$	$8\frac{1}{2}$
All other brain diseases (all ages).	23	$20\frac{1}{3}$	$26\frac{1}{2}$	22

* Typhoid in 1853 caused 34 deaths per 10,000.

A considerable and progressive reduction of the total mortality will be observed, a reduction of pretty constant amount from year to year.

An increase in the rate of infantile mortality, calculated upon aggregate population, very probably arises from a much increased birth rate under the altered social circumstances of the town. This opinion has not been brought to numerical proof, but it is so probable that no importance canbe attached to the apparent increase of mortality in infants.

The more contagious epidemics have caused fewer deaths. Continued fevers, after an accession of fatality in the earlier period of the drainage works, have steadily subsided to one-third of their former amount, and this is true even after exclusion of the deaths presumably caused by true typhus in the epidemic of 1848–9. Diarrhœa has been reduced.

The diminution in mortality from consumption and lung diseases is notable : they are taken together in Dr. Westall's tables. It is to be regretted that consumption has not been considered separately.

A reference to the preceding tabular statement will show that cholera which caused 27 deaths in every 10,000 of the population in 1849 was not much less fatal in 1854 after many of the drainage works had been executed. But it is stated by Dr. Westall and Dr. Carpenter that in 1849 the deaths occurred chiefly in the centre of the town, which in 1854 escaped with a very trivial mortality, the deaths on that occasion being most in the outer north-eastern portion of the district and chiefly about the Common where the drainage works were not completed, where the old nuisances abundantly existed and to which the water supply had not then been given.

Fever at Croydon.

The increased prevalence of typhoid fever in 1853, in the middle of the drainage operations of Croydon, demands more than a passing notice. The following concurrence of unwholesome conditions is given by Dr. Carpenter as having produced this great excess of fever :—

1. The disturbance and redistribution of immense deposits of filth ; and 2, the probable pollution of every well in the town. 3. The excessive rainfall of the season (34·16 inches) leading to an overflow of the Bourne, and flooding the sewers as fast as they were laid down. 4. An unfortunate omission to ventilate the new sewers in a proper manner.

These conditions were, as far as possible, remedied in the subsequent steps taken by the board of health, and their connexion with the fever appears established by the fact that since their removal typhoid fever has been a disease of rare occurrence in Croydon. In one year only, between 1845 and 1855, were the fever deaths less than 11·4 per 10,000 of the population ; in no year from 1855 to 1864 were they more numerous than 8·4 per 10,000. It is believed, too, that since the sanitary works, most of the fever deaths have occurred in the outlying parts of the parish and not in the town of Croydon itself.

But still, fever has not been wholly banished from Croydon, and its occasional occurrence has given some instructive lessons. Thus, in the latter part of 1858, fever appeared in the eastern and central districts ; that year was particularly dry, and the sewers had not had their previous amount of flushing ; after the sewers were thoroughly flushed by the local board, the fever subsided in a marked manner, and a regular system of cleansing them having since been adopted, the annual deaths from fever were again considerably reduced. But again, quite recently in 1865, typhoid has prevailed somewhat extensively in Croydon, and those who had most positively asserted its previous decrease to be due to the system of drainage, set to work anxiously to discover any defects in the operation of that system. In the following extract from a pamphlet by Dr. Carpenter, satisfactory evidence is adduced of the connexion of the fever with a still imperfect ventila-

tion of the sewers, or with local defects in the drainage of particular houses:—

"The fatal cases occurred nearly altogether in point of time—appeared simultaneously in many parts, but principally in new houses. On inquiry, I found that all the earlier fatal cases dated the commencement of illness from two distinct periods. Now those periods were preceded by a very heavy rainfall: on one occasion nearly $1\frac{1}{2}$ inches of rain fell in the preceding 24 hours, and on the other, nearly 1 inch; on each occasion the temperature was high, and there was an entire absence of ozone in the atmosphere. I do not mean to assert that each case actually commenced immediately after the rainfall, but in upwards of 20 fatal cases, into the history of which I examined, the commencement curiously ran up to two distinct dates, and of many slighter cases the patients stated that they had not felt well from about the same period. To what cause could those isolated cases of fever be attributed? how had the rainfall acted? and why should it act injuriously upon a perfectly well-drained town? Unfortunately for myself an experiment was performed before my eyes, which enabled me distinctly to point to cause and effect. My own house is connected with one of the main sewers, and has for many years been protected by a ventilating pipe, which, ascending from the soil-pipe of the closet, was made to terminate for convenience near a cistern of large size outside the top of the house. On the night of October 17th I was aroused by a loud noise proceeding from the closet; it continued at intervals throughout the next day. Unable at first to account for it, I eventually found that it was caused by the ventilating pipe, doing duty as waste pipe to the overflowing cistern. There was no room for exit of foul air from the sewer, which therefore was forced through the trap of the watercloset, with at times the force of steam through the safety-valve of a steam-engine. The nuisance continued for nearly three days, before the weather would allow the plumber to rectify a mistake which had been committed in the previous summer—the mistake of making the ventilating pipe do duty for a waste pipe. The escaped air did not smell offensively, a faint odour alone being recognized; it was therefore thoughtlessly tolerated; the excessive rainfall also prevented much ventilation of the house by open windows. Two or three days afterwards, one of the occupants of a room, the farthest in the house from the closet, fell ill with symptoms of typhoid fever, and in a few days the other person sleeping in that room also showed signs of the disease; no other person in the house suffered from it. Into the room occupied by these two persons, the foul air from the closet, as proved by experiment, naturally ascended. Simultaneously with the origin of these cases appeared many others in various parts of the town, and in every case in my own practice in which enteric or typhoid fever occurred, I distinctly traced local causes for the disease in some defective housework. It generally happened that the smell was not enough to lead to the discovery of the defect, a faint odour alone being perceived. In my own house it was the noise, not the smell, which led to the early discovery of the error; and that which happened on a large scale in my house occurred also in a smaller degree in the houses of many others, for it happens by an old rule of the local board of health, that the rainwater pipes have been allowed to be ventilators to the sewers; on ordinary occasions, therefore, the sewers have been fairly ventilated, but whenever there has been an excessive rainfall, the escape of air has been impeded by the fall of water, which has been poured in abundance in a comparatively warm state into the impermeable pipes, at the very time that gas in large quantities has been evolved."

"Our present engineer is fully alive to the necessity of a proper plan of ventilation in the main sewers, and is carrying out a very efficient scheme."

The connexion between the improvements in Croydon and the better state of the public health since the completion of the works appears then to be established as much by occasional failures as by general success. But another element must not be lost sight of in this consideration. Owing to the rapid increase of the town by the residence in it of well-to-do Londoners, the poor, among whom there is always a larger mortality than among the rich, have of late years constituted a smaller proportion of the town than 20 years ago. While assigning all due weight to this fact, it must be stated that typhoid fever at any rate has made no such distinction of classes, and that in its recent exceptional appearances at Croydon, the good houses have perhaps been attacked even more than the poor ones, doubtless through the better houses having more generally inside waterclosets.

CARLISLE.—Population of City, 1861, 29,417.

CARLISLE.

Early sanitary condition.

From Mr. Rawlinson's elaborate report on a preliminary inquiry into the circumstances of this city in 1849 the following account of its condition at that date is extracted :—

Soil.

" The city stands on the new red sandstone formation." " Alluvial " beds of peat, clay, marl, sand, and gravel, varying from a few feet to " many feet in vertical thickness," are superposed to the sandstone rock. " It will be partly through this irregular deposit that the drains and sewers of the city will have to be formed."

Site.

The city, although nearly surrounded by the rivers Eden, Caldew, and Petteril, lies at an elevation above them, the highest level in the town being $48\frac{1}{2}$ feet above the water of the Eden. In 1849 the surface rainfall passed off into these three rivers. Certain portions of the city lying low were liable to be flooded by the great rise in the several rivers which have their sources to the south and west in the Cumberland mountains. " The main outlet (to be made for sewage) will necessarily be at times " flooded by the waters of the Eden."

The mean rainfall in 24 years was $30\frac{1}{2}$ inches, varying from 35·8 the highest to 25·7 the lowest annual amount. " Carlisle is liable, from its " situation in the valley of the Eden, to damp fogs, and an extensive " system of deep land drainage would diminish these."

Construction.

" The working classes in Carlisle live almost entirely in 'lanes' or " passages between the principal and secondary streets; courts and " alleys they would be termed in other places. Many of these lanes are " entered by a covered passage, and some are closed at one end. They " are generally only a few yards in width. Their arrangement often " obstructs light and ventilation. Some of the cottages are in single " rows, but others are built back to back, in either case there being no " opening in the back or side wall. These houses are let off in room " tenements, having one common stair to several tenancies; this is " generally of stone. Room ventilation is most imperfect." By these arrangements the central parts of the city were very closely built on and thickly tenanted. In Mr. Rawlinson's report plans illustrating

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remarkably the crowding of buildings together are given; one of them represents a "block of property consisting of lanes, courts, and yards, "banks, shops, hotels, stables, cowsheds, schools, and dwelling-houses, "amongst which are crowded and confined yards, privies, cesspools, "middens, and other nuisances."

Sewerage.

Street sewers and drains on an irregular plan existed in parts of Carlisle in 1849. They were all inefficient for the purpose of removing refuse, and they discharged into open drains; of these there were 9,790 lineal yards, and 2,896 square yards of the area of such drains were giving off noxious gases from the whole surface. Privies with middens, into which ashes as well as privy soil were received, were the almost universal form of convenience; but since 1830 some waterclosets had existed draining into ditches surrounding the town, and being flushed as best they could be by the imperfect water supply then to be had. Privies of any sort were in very inadequate numbers. "In "many instances there is only one privy to a whole lane, and this "is ruinous and filthy. In some lanes privies and middens are "crowded amongst the houses and not unfrequently under the same "roof; or they are in contact with a dwelling-house on each side, and "have living and sleeping rooms above them. The infiltration from "the middens and liquid refuse in contact with the wall in some "instances passes through, to the great inconvenience of the adjoining "occupants."

Water supply.

The water supply of Carlisle up to 1848 was by pumps and by carts carrying barrels filled from the Eden. The pump water was very hard and impure. In 1848 a new supply was afforded by a private company which raised water from the river Eden. The water after filtration was conveyed into a large reservoir 40 feet above the level of the highest ground in Carlisle, from whence the water flowed through pipes to all streets and places in the borough. The supply was on the constant system without cisterns, and was furnished to 3,217 houses, or more than half of the borough, at the date of Mr. Rawlinson's inquiry. Cisterns were only in use in connexion with waterclosets, and it was found necessary to have them there to prevent waste of water. The water contained eight grains of saline matter and an inappreciable quantity of organic impurity.

Cleansing.

Many of the streets and smaller thoroughfares were imperfectly swept and paved. In Caldewgate ward "the lanes and courts are in a most "objectionable state, containing almost invariably pigsties, open privies, "dunghills, stagnant pools the receptacles of every kind of filth; all "which nuisances remain unheeded for weeks and months together." This extract is from a report of the Carlisle Sanitary Association, for the accuracy of which Mr. Rawlinson vouches. The report speaks of "most

Nuisances.

"intolerable nuisances," "fearfully dirty privies," "numerous pigsties," and "disgusting necessaries," "large pools of stagnant noxious fluid," "one privy for 20 families, and this has not been cleaned out since "built." Other wards are described in almost similar terms. In Rickergate ward "the committee can hardly find words to express the "amount of filth, or to depict the abominable nuisances existing."

There were 18 slaughter-houses crowded among dwelling-houses, ill-drained and causing frequent nuisance.

Overcrowding by subletting of houses into separate tenements appears to have existed to a considerable extent in the lanes and poor streets. The common lodging-houses were numerous, unregulated, crowded, indecently occupied. Vagrants passed through the town in large numbers.

A house of recovery for the treatment of contagious diseases was in constant requisition for the manifold fevers of the city, and some people were brought to it from beyond the city boundaries.

In 1854 Carlisle began its works of sewerage and drainage, which were fairly completed in 1857. Many private works were then done, but more have been carried out every year since. The public works consist of an outfall sewer into the Eden of 3 ft. 9 in. by 2 ft. 6 in., with the small but sufficient fall of 1 in 1,000, and of smaller sewers and street drains down to 9 inches in diameter. The same sewers are used for draining houses and for the storm water. The sewers are provided with flushing arrangements (*a*) from all streams crossed in their course; (*b*) from a large water chamber at the highest part of the town, by which a large body of water can be sent down the sewers in any required direction; (*c*) in small streets that have a bad fall, by hose and hydrants. Except the downspouts which are reserved for ventilation, all inlets to the sewers, whether in houses or in the streets, are trapped. Special means of ventilation are provided by connecting the sewers with some very tall factory chimneys.

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Sanitary operations.

Of sewerage.

The sewage of almost the whole town is delivered to a contractor at the outfall. The whole, or a portion of it, is mixed with crude carbolic acid, raised by pumping to a sufficient level, and is then used for irrigation.

Effect on subsoil

Mr. Rawlinson reports (1856), "the whole subsoil of the city having "been trenched for the purpose of putting in the sewers, the land is "drained to the full depth, thus removing not only the waste waters of "the city, but the subsoil waters also."

In confirmation of the sewerage having had this effect, the city surveyor states that shallow wells were drained by the works to such an extent that many people shortly after the sewers were completed had their wells deepened, and others finding the yield of water cut off adopted the water company's supply. And Mr. Rawlinson writes in 1867, "I "have no doubt as to the draining of the subsoil of the city proper. It "is well drained. Caldewgate is, however, so low that the subsoil is "water-logged at all times, and in flood is practically under water."

on removal of excreta.

All the middens in the central parts of the town were abolished and waterclosets erected in their stead. In narrow lanes where there was insufficient room for the common closet a house was sometimes demolished to provide a proper place for it. Most of the waterclosets were made on the ordinary pattern, but for cottage property Macfarlane's closets have been largely adopted. The privy with a midden was allowed to be retained in some of the outer parts of the town, but these were all drained and kept dry. Many conveniences were erected where there formerly was none.

Water supply extension.

The water supply remaining in the hands of the company, was improved and extended till every house was supplied. In many lanes of the central parts of the city not only has water been supplied to every house separately, but even to every tenement and to every room where rooms are let out as separate tenements.

Paving and nuisance removal.

After the drainage works, which had involved extensive disturbance of the surface, the main streets and the lanes of the central portions of the town were thoroughly paved and flagged. Under byelaws of the corporation the slaughter-houses have been drained, supplied with water, and regulated. Pigs have been removed from any place where they were a nuisance, or whenever they were kept within 10 yards of a dwelling, and few only were left in the central parts. This byelaw was made under the Municipal Corporations Act. And all more palpable nuisances were removed from the central parts, and the courts and lanes kept as clean as inspection could keep them, although in the circumferential parts of the town many courts have until lately, and some up to the present time, remained in the filthy condition of former times. Byelaws were also enacted for the construction of new houses, forbidding them to be built

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back to back, and regulating the area for each, and a code of rules was enforced for common lodging-houses. A sanitary inspector was appointed to enforce the Nuisances Removal Act and the byelaws of the corporation, and every few years a sanitary committee has made a careful inspection of the town. A distinct improvement in the condition of the town has followed each of these systematic inspections of committees.

Present sanitary state.

As to sewerage, &c. in central parts.

The present sanitary state of Carlisle, when compared with the description of it in former times, shows for large portions of the city (and indeed for the whole that would come under notice by an ordinary visitor) a very striking degree of improvement. To consider first, then, central parts of the town. The system of house and street sewerage is in perfect order, and, except on the unavoidable occasion of floods, all refuse is at once and rapidly carried away. Waterclosets are universal and kept in good order, Macfarlane's especially being found admirably suited to the wants of poor neighbourhoods. The streets or courts are kept clean and free from nuisance. The serious constructive defects of the town are not indeed remedied, but a good many houses have been removed for the erection of warehouses and some few to permit the construction of water-closets in proper places. The poor are better lodged, and are much less overcrowded than they formerly were. Common lodging-houses are in a decent and not crowded state. Water is provided universally, and in some lanes every single room, where houses are sublet in rooms, is separately supplied, a sink with an efficient and well-contrived trap being provided in connexion with the water supply.

Even with the improved means of cleanliness given in the poor houses of the lanes it is most satisfactory to observe the class of people who formerly lived in them have got dissatisfied with living in these close and confined alleys. They have profited so well by the sanitary education of their sight and smell that they now demand a better sort of dwelling altogether. The artizan class are, therefore, in large numbers leaving the central parts of the town, and going to live in the more surburban parts where, for nearly the same rent as a room in a court, they can have a trim new self-contained cottage, built with reasonable provision for their wants. To this cause, even more than to the destruction of courts for warehouses and to the demolition of some places by the railway, is ascribed the diminution of population in the central parts of the town. Again, the poorer labouring population are taking the rooms and houses vacated by those of a class a little higher than themselves, and in their turn are learning the advantage of cleanly dwellings.

In other parts.

But in some of the old parts of Carlisle, away from business quarters of the town and yet not in the suburbs, there remain a number of courts and yards which are full of nuisances, and keep up the memory of what the whole town was in 1849. Into Botchergate, house drainage has only just now penetrated, and a good many courts remain in the condition of one which deserves to be specially mentioned, inasmuch as it is the property of an ex-mayor who neglects (Sept. 1865) to improve it even after official notices. This is a closed court at the end of which are two common privies with a midden exposed just under the windows of a dwelling-house. There is no drain to the court, to the midden, or to a urinal in a corner, except a mere surface channel. The rooms are held direct from the ex-mayor, who is therefore responsible for such tenancy as the following: a man, his daughter of 17, and his two sons of 15 and 7 living together in a single room, of which the window is obliged to be kept shut to exclude the ashpit stink; or another tenancy of an old woman, her brother, and two lodgers in a single unregistered room; or for a cottage of four rooms where four families of 17 persons lived. Parts of Caldewgate, too, remain as bad as these Botchergate courts, having piggeries in some numbers, ill-paved yards, and full undrained middens closely mixed among the cottages.

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But such districts do not constitute a very large part of the whole town, and even they are now supplied with water, and the foul ditches that ran through them have been restored to clear streams. The irrigation works are answering well and profitably, and no nuisance is made by them or by the refuse water discharged into the river.

Water, quantity and quality.

The water of the company is now used to the complete exclusion of the supply from wells, except in some suburban cottages about Caldewgate. Day and night the company's works give a continuous supply amounting to 1,000,000 gallons a day or 33 gallons for each person, from which a deduction must be made for manufacturing and some other purposes. It is delivered at a pressure that reaches the tops of the houses in the highest parts of the town during the night, but not during the day, while a large use and waste is going at lower levels, diminishing the pressure. As to its quality there appears much difference of opinion; analysis recently made for the company by Professor Miller gives 10½ grains of fixed salts and 0·44 grains only of volatile and combustible matter partly organic. In all respects nothing could be better than the water submitted to analysis, and no change in the quality of the water is known to the company since the chairman made in 1849 the statement that of all the cholera cases (producing 51 deaths) that happened in Carlisle in 1848 not one was found in a part of the town then supplied by the company's water. But popular evidence does not support the analysis of these samples. At times of flood it is said to be muddy with animalculæ in it. Another informant says it is milky and has a bad taste in the summer; others think the sewage of Penrith, which is poured into the Eden some miles above, or the manuring of fields along the course of the Eden, may have caused an impurity of water in late years. A medical practitioner in attendance on a children's workhouse in Carlisle thinks the water is bad and affects health injuriously. And Mr. Rawlinson regards the water supply as defective, inasmuch as it is derived originally from an impure source (the river immediately above the city), is stored in open reservoirs, and is not efficiently filtered.

The difference of statement about the visible quality of the water very probably comes from its being better filtered at one time than another, but it is plain that there is need of frequent and independent analyses to settle the question of its goodness.

Mortality statistics.

Taking the whole area of the city for the purpose of statistical inquiry, and excluding those parts of St. Cuthbert and St. Mary's sub-districts which lie beyond the city boundaries (but including Caldewgate workhouse as receiving poor mostly from the city), the mortality tables appended to this report have been obtained. Correction has been made in them for the persons who were brought from beyond the city and died in the House of Recovery, so that the statistics of contagious disease may be taken as free from error; but no correction has been made in respect of persons belonging to outlying parishes of the Carlisle Union, and dying in the workhouses. No important fallacy can come however of this want of correction, seeing that the practice of earlier years will not differ materially from that of more recent ones in this respect.

The following is a summary of the death statistics divided into three periods—(*a*) before the drainage works, but comprehending a portion of the time during which water was supplied by the company to a majority of houses in the city; (*b*) the time during which the public works of drainage and sewerage were executed, and when a great many houses were connected with the drainage system; (*c*) the period after the main (during which a further and continuous improvement has been going on) up to the present time, when the main parts of the city have reached a comparatively satisfactory state:—

Mortality per 10,000 of all Persons living.	Before (9 years 1845–53) execution of Drainage Works.	During (4 years 1854–57) execution of Drainage Works.	After (7 years 1858–64) execution of Drainage Works.
All causes, all ages, both sexes	284	269	261
All causes : children under 1	71	$67\frac{3}{4}$	$65\frac{1}{2}$
Males -	39·5	38·0	36·2
Females -	31·6	29·8	29·2
Epidemic diseases :—			
Smallpox, all ages - -	$7\frac{2}{3}$	$2\frac{1}{2}$	$1\frac{1}{2}$
Under 5 -	6·1	1·3	0·9
Over 5 -	1·5	1·1	0·6
Measles, all ages - -	$7\frac{1}{3}$	$7\frac{1}{2}$	$6\frac{2}{3}$
Under 5 -	6·6	6·9	6·0
Over 5 -	0·7	0·6	0·6
Scarlatina, all ages - -	$15\frac{1}{2}$	$18\frac{3}{4}$	$11\frac{3}{4}$
Under 5 -	11·3	11·4	7·1
Over 5 -	4·2	7·3	4·7
Diphtheria, all ages -	$0\frac{2}{5}$	$0\frac{4}{5}$	$2\frac{2}{3}$
Whooping-cough, „ -	$6\frac{1}{3}$	$6\frac{1}{2}$	$8\frac{1}{2}$
Croup, „ -	$2\frac{5}{6}$	3	5
Erysipelas, „ -	$1\frac{1}{10}$	1	1
Rheumatic fever, „ -	$0\frac{5}{6}$	1	$0\frac{3}{4}$
Fevers : typhoid, &c. „ -	10	$8\frac{3}{4}$	$9\frac{3}{4}$
Under 5 -	2·2	1·2	1·3
Over 5 -	7·9	7·5	8·4
„ presumably true typhus.	$2\frac{1}{2}$ (but all in epidemic years, 1847-48.)	—	—
Diarrhœa, all ages - -	$11\frac{1}{3}$	$11\frac{1}{2}$	$12\frac{1}{2}$
Under 5 -	7·5	8·0	10·0
Over 5 -	3·9	3·6	2·6
Cholera, all ages - -	(In 1849, 22·1.)	(In 1854, 6.)	(In 1866, 0.)
Dysentery, „ - - -	$0\frac{5}{6}$	$0\frac{1}{6}$	$0\frac{1}{3}$
Phthisis, all ages, both sexes	32	31	$35\frac{3}{5}$
Under 5, males -	0·17	0·09	1·70
„ females -	0·22	0·18	1·45
15–55, males -	12·8	13·6	13·2
„ females -	12·9	12·7	14·4
Lung diseases, all ages, both sexes.	26	$31\frac{1}{2}$	$32\frac{1}{6}$
Under 5, males -	4·6	8·0	6·4
„ females -	4·4	5·4	7·4
15–55, males -	2·9	2.1	2·3
„ females -	3·6	2·4	2·3
Brain diseases, all ages, both sexes.	$32\frac{1}{6}$	$35\frac{1}{2}$	38
Under 5, males -	10·8	11·8	11.1
„ females -	6·3	8·5	9·0
35–55, males -	1·74	1·97	1·64
„ females -	1.56	1·43	1·60

Summary results.

Some diminution in the total mortality has taken place, and since the public works the mortality of the town has never reached its high previous rate of 33 and 40 in the 1,000. The rate of mortality among infants under one year old has somewhat decreased. But among all the causes of death that have been specially investigated there are few that show any important reduction, while several prominent causes have been actually more fatal than formerly.

Smallpox deaths have fallen from nearly 8 to $1\frac{1}{2}$ in the 10,000 residents. Measles has very slightly decreased. Scarlatina has been less fatal by a quarter of its earlier amount.* Whooping-cough has caused a third more deaths in the later than in the earlier period. Continued fevers, after correction for admissions into the House of Recovery from beyond the town, have decreased in the proportion of about 5 to 4, but if it be surmised that the large excess of fever deaths in 1847–48 were due to imported Irish typhus, and that true typhus has at other times been prevalent to a constant amount, then after correction of this kind the figures representing the mortality from typhoid fever would show scarcely any reduction, and any reduction is exclusively in children under five years of age, in whom the cause of death "fever" is apt to be more vaguely applied. Diarrhœa (with dysentery) shows a stationary mortality, but in infants a slight rise. Cholera, which produced a small epidemic in 1849, was very much less fatal in 1854, and only stray cases have since occurred; none in 1866. Phthisis has increased somewhat in adults and in children, the greatest proportionate increase being among infants, but there is room for numerous fallacies here, a note on which is subjoined.† Lung diseases and brain diseases of children under five have lately been more fatal. In adults neither of these classes of disease caused more deaths.

Fever prevalence.

The admissions into the House of Recovery corroborate the statements respecting fevers above derived from the death registers, but the following figures include persons admitted from beyond the city:—

Admissions for Continued Fevers only.

1845	25	1850	6	1855	23	1860	50
1846	23	1851	7	1856	23	1861	33
1847	174	1852	8	1857	55	1862	42
1848	31	1853	53	1858	88	1863	38
1849	19	1854	36	1859	45	1864	48

The mean of the annual admissions before 1854 was 38 on a mean population of 25,500 people; or, without the year of what was presumably epidemic Irish typhus, $21\frac{1}{2}$ only. After 1857 the mean annual

* Of this disease it may be well to note that it came before 1854 in two tremendous epidemics lasting about two years each, and after each epidemic there was a year without a single scarlatina death: while since 1857 it has never been wholly absent, but has never caused in one year a mortality approaching that of the former period. Nearly the same change has occurred in the manner in which measles has prevailed.

† In nine years, 1845–53, only nine deaths were registered in Carlisle from phthisis in children under five. In seven years, 1858–64, 65 such deaths were registered, or, with allowance for difference of population, eight times as many annually. The number of such deaths on the register began to increase exactly in 1858, and year by year it has since been high. No importance can be attached to this fact when it is considered that what one medical practitioner puts down to "marasmus" or "atrophy," another may assign to "consumption" or "infantile phthisis," or, again, that true tubercular phthisis in children is by no means universally recognized and defined by medical practitioners, so that a new comer in 1857 may have really detected a not unfrequent cause of death that had seldom before been accurately assigned.

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admissions were 49 in a population of 29,400. This would appear to show recent increase of about 12 per cent. on the mean of former admissions, but without accurate knowledge of the districts whence people came, whether in or outside the city, and of the rules and management of the house, it would not be safe to insist much on this. But concerning the very notable decrease of admissions in 1850–51–52 the committee of the fever house prints the following statement :—

" Under the auspices of this institution the first sanitary inspection of the city was made in 1831, followed by a second inspection, less exclusively theirs, in 1843, a third in 1847, and a fourth in 1849 ; the last under government commissioners. A reference to the table of fever cases alone, every year since 1820, will show how remarkably these inspections, systematically and simultaneously made over the entire city by a number of organized committees, have always operated. It is in the year following such inspections that the marked diminution of fever cases may be noticed. The diminution, however, is not confined to these particular years 1832, 1844, 1848, and 1850, it includes the two years following each of them. Twenty-three fever cases are the average of these 11 years, whereas 78 per annum is the average of the other 25 years up to 1856. Since 1850 no such inspection has been made, though the town has been perambulated by an officer of police appointed as inspector. We have then had three times as many cases of fever every year in Carlisle when nuisances were tolerated as when such nuisances were carefully reported and removed."

These statements cannot in all years stand the obvious criticism that an inspection would more likely be made in a year when fever is abundant, and that in years after an epidemic there is usually in any case a smaller prevalence of fever. Still this criticism does not apply to the inspection of 1849, and there does appear strong evidence of the direct value of intelligent supervision. Regarding the facts stated it is to be observed that, in an important city like Carlisle, sanitary inspection by skilled observers (among whom Dr. Elliott deserves foremost mention) has been left to the zeal of volunteers and the occasional exertions of charitable committees. A medical officer of health at the head of the sanitary staff would give the advantage of such skilled supervision continuously.

Dysentery at asylum.

In concluding this account of Carlisle it is well to draw attention to an outbreak of dysentery which occurred in 1864 at the lunatic asylum, and which being beyond the city is not considered in the statistics of the city mortality.

The following table shows the deaths in the asylum for each quarter of 1864 :—

Year 1864.	Brain &c. disease.	Dysentery alone, or as complicated.	Other Diseases.
1st quarter - -	2	–	–
2nd quarter - -	1	2	*6
3rd quarter - -	–	7	1
4th quarter - -	3	–	1

* 2 complicated with inflammation of the intestines.

Dr. Clouston, the medical superintendent, had an interesting paper on this outbreak in the Medical Times and Gazette 1865, and connected it with the irrigation by sewage of land in proximity to the asylum.

Macclesfield.—Population, 1861, 27,475.

Previous sanitary state.

The state of this town before the Public Health Act came into operation is described by Mr. Smith, who examined it in 1849, and by Mr. Rawlinson, who visited it in 1851.

Site and construction.

"The country around rises to a considerable height, and the town is "well sheltered on the east and west, but chilling winds and mists are "prevalent." "The average fall of rain, taken on two years, is 40 inches "per annum." "The chief part of the population are engaged in the "silk manufacture, and earn fair wages." "The 'town stands on "several sloping sites,' is irregular in its building, arising in some "degree from the irregular features of the surface. The streets of the "older part are very irregular." "A great portion of the borough is "very ill-paved." "Many of the streets in the suburbs are actually "impassable to wheeled vehicles, the consequence is that the houses in "the streets do not let for their full value, as nothing short of imperative necessity could induce persons to rent them." "Few places "present greater facilities for good pavement and cheap drainage than "Macclesfield." "Considerable improvements have lately been effected "in the repair of streets and sewers, but a great deal still remains to be "done." "The great want of proper scavenging is a subject of general "complaint; everywhere heaps are to be found at the sides of the "streets that must have stood a considerable time there."

"Cottage property is built in general without due regard to sewerage "or ventilation." "Damp prevailed to a great extent in these cot"tages." "Half-sunk cellars in the older parts of the town are very "damp, and the back yards are often covered with water, green from "long standing, and quite covered with rubbish."

Soil.

"The soil on the west of the town near the river is sand lying over "clay. On the east there is no sand over the clay; in the hilly parts "of the town the sandstone rock comes to the surface. These strata "either contained or held up plentiful springs of water."

Sewerage.

"Very few of the houses are properly drained; most of the sewers "are not sufficiently deep for the purpose of house sewerage, and in "several instances the sides of the sewer and the walls of the houses "have to be puddled to prevent the cellars being flooded with sewage "water." "The conveniences to the cottages are generally detached "from the house." They consist usually of a "privy and open midden"stead." "The proportion of privies to the number of houses is very "small, and the contents until very lately were often allowed to accu"mulate until the pit became quite full, when it was necessarily emptied. "There is no rule systematically followed for the removal of night "soil." "The principal channel for conveying away the sewage of "Macclesfield is the small river Bollin, which runs through the centre "of the town and is joined by several smaller streams into all of which the "sewage and surface water from the streets and houses runs. The Bollin "is very much choked up with rubbish, and its flow interfered with. "Smells are much complained of along its course." "Many streets are "wholly unsewered, and open sewers are very frequent." "A good many "sewers have lately been put down, but without any general plan. "Older sewers are very badly constructed, without any regular gradient, "and allow the sewage to escape into the soil." "None of the gully"holes are trapped."

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Waterworks.

" There are waterworks in Macclesfield owned by the corporation; " 3,572 houses are supplied with water from these works, 4,784 are not " supplied. The present works supply about 12 gallons per head daily, " including the supply to 40 public works. In dry seasons the supply " falls to about five gallons per head per day. The service reservoir is " 60 feet above the highest, and 159 feet above the lowest part of the " part of the town. The water is of 4·1° of hardness. Many parts of " the town are very badly supplied with water, and numerous com- " plaints are made." " The present waterworks are found insufficient " for the wants of an increasing population, and the corporation has " now obtained an Act for the better supplying of the town." In one district there is a private source of supply to 200 houses; another district "depends almost wholly on pumps and wells which were found in " many instances tainted with the percolation of the soil."

Nuisances.

" Until 1848 nothing was done towards the removal of nuisances, " but at that time when cholera began to be talked about, some con- " siderable improvements were effected under the Nuisances Removal " Act, and in a fortnight the surveyor to the commissioners removed " 1,500 tons of manure out of the town, but the commissioners then " gave him orders to stop, and nothing has since been done. Slaughter- " houses are not specially nuisances." Notes abound in the reports of the inspectors of "sewage water on the surface," "great accumulations " of dirt," "courts covered with green fœtid matter," "heaps of filth " lying about," "privies with middensteads disgusting to the smell and " sight," "disgustingly fœtid matter from a cowshed," "dung heaps " allowed to accumulate in the streets," "cesspools with poisonous " stench that have not been opened for 8 or 10 years."

Lodgment.

" Overcrowding of houses prevails to a great extent in Macclesfield, " and the medical gentlemen state that lodging-houses and overcrowding " in general give rise to a great proportion of the fevers which " occur." "As cases of fever occur among the poorer classes of the " town, they are removed to the workhouse." In 1849 "there were a " great many cases of fever in the workhouse, and a temporary ward " had been erected for their accommodation." The state of the common lodging-houses at this period is told in the following extract from a report of the proceedings taken by the local board in 1853, its first year of office:—

" Notices were served upon 224 lodging-house keepers, calling upon them to register their houses. These houses were inspected by the officers, and it is impossible to convey even a faint idea of their condition. The state of filth in every form, the overcrowding, the mixture of sexes, and the moral degradation consequent upon it, in three or four localities, could not be exceeded in the worst parts of the metropolis. In four small cottages, with two bedrooms each, and two rooms on the ground floor, there was an average of 188 persons lodged; they had a small yard, the remains only of what had been two privies, all the ordure in the open yard; and in this yard was also a building in a loathsome condition occupied by a man, his wife and child, and one female lodger, the dimensions of the room on the ground floor being 6ft. 2in. long by 4ft. 4in. wide, and 5ft. 4in. high, and the bedroom 9ft. 8in. long by 4ft. 4in. wide, and 5ft. 4in. high. This had been a nailer's shop, and the walls and floor were jet black. In the same yard, in one bedroom 8ft. 9in. by 9ft. and 7ft. high, lived a husband and wife and six children. In another lodging-house near, there were three small rooms upstairs; in the first were 16 men, women, and children, lying together on the floor; in the second, there were 12, also on the floor; and a third room upstairs was used as a privy, the boarded floor being literally covered

with human ordure. In the cellar two men lay on a bed on the floor. This was on the last visit. In the same yard and at the same time, at another lodging-house, in worse condition than the last, there was a bed in the house-place on which lay a woman in the pains of labour, by her side lay a man apparently asleep, and ten other men, women, and children were in the same room. (This was at 2 o'clock a.m.) In a back place, with the window out, and used as a receptacle for the filth of the house, lay three little children in some shavings. In the room over this lay six women and children on the floor, and in the front room were four beds on the floor filled with men, women, and children, varying from two to six in a bed. At another lodging-house, the same night, either 17 or 18 thieves and prostitutes were found drinking and playing at cards; they all escaped over the yard wall on being visited, in the expectation that it was the police. This description is an index to many others."

Sanitary operations.

The following account of sanitary works at Macclesfield is compiled from the reports of the local board of health, given me by Mr. May, to whose administrative abilities the town is as much indebted as to the executive capacity of its surveyor. The chief works were executed in the years 1853–6 inclusive:—

Of sewerage, paving, &c.

The board set out with a plan of improving certain streets at a time, including in the works, every sanitary requirement of the street, and of its adjacent courts, with the street-houses and the court-houses. Under section 69 of the Public Health Act, the board undertook not only the sewering and paving of the streets, but also the flagging and draining of the yards, rebuilding and draining of the privies and ashpits. This scheme was carried out, partly by the officers of the board, partly under contract, and experience showed that the works were done more systematically and more satisfactorily than if the board had only done sewering and paving, and had called on the owners of houses and of private courts to do the remaining works of house draining, flagging, and privy improvement. In 1857 the board of health reports 43 streets and 245 courts newly sewered, paved, and flagged, with the following description and quantity of work:—

Excavating - - -	29,822	cubic yards.
Main sewer - - -	6,138	lineal yards.
Branch sewers - -	2,206	"
Brick and stone sewers -	515	"
Flagging - - -	18,133	supr. yards.
Paving - - -	21,623	"
Crossings - - -	2,346	"
Macadamising - -	10,485	"
Gravelling - - -	2,742	"
Edging - - -	10,548	lineal yards.
Channelling - - -	4,551	"
Traps and gulleys - -	752	"
Brickwork - - -	2,010	supr. yards.
Bolders - - -	159	"

The length and sizes of the sewers laid down as follows:—

16-inch by 12-inch pipes - -	5,080	yards.
12 " - - -	914	"
9 " - - -	2,359	"
6 " - - -	12,476	"
4 " - - -	6,323	"
3 " - - -	694	"

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About 1,600 houses had been thus benefited at an expense of 15,944*l.*

The house drains are mainly 6-inch pipes with every opening trapped, except the downspouts, which are used for ventilation. Besides pipe sewers, others of brick are used in all cases where the sewer exceeds a certain length. The main sewers (over 18 inches) are of brick, and about two miles of such sewer extends to the outfall. The sewers discharge themselves into the river in the centre of the town; but this is not intended to be a permanent arrangement, as an intercepting main will be shortly (1865) constructed to convey all sewage underground out of the town. The sewers receive the storm-water as well as the house drainage. Flushing tanks also are provided at the head of each main.

About half of Macclesfield township was gone through before 1857, including most of the worst parts; and after that few new places were taken in hand, but the paving of the main streets has since been much improved.

The system of middens has been retained, but the privies, to the number of 300 to 400, have been repaired or rebuilt in the best available positions, and the ashpits have been carefully drained so that they are commonly found quite dry. The use of waterclosets has not been encouraged, partly through the intercepting sewer not being ready to relieve the river from pollution, and partly, it would seem, because people are more accustomed to the midden.

Water supply extension.

The water supply was improved in 1851–52, an increased amount of water being obtained from a gathering ground on the hills above the town. The continuous system of service was maintained, and the town has never since been short of water. Nearly all the houses in the town have been connected with the waterworks, of which the daily supply has been brought to 25 gallons per head per day, including a small proportion used for trade purposes.

Cleansing.

Some hundreds of houses yearly have been limewashed by instructions of the board. Pigsties, which had abounded in the borough, have been removed. Slaughter-houses have been registered and supervised. Scavengers have been employed to sweep the roads and courts, and to attend to the state of the sewer-traps.

Regulation of lodging-houses.

Immediately upon entering on their duties the board took steps to regulate common lodging-houses, insisting on every requisite being provided for a separation of the sexes, for cleanliness and ventilation, water supply, and proper out-offices and drainage, and limiting the number to be lodged in each room. 41 lodging-houses were at once registered to accommodate 444 persons, and a report was made weekly to the board as to their condition, no infringement of the minutest regulation being permitted. The registered houses have thus been immensely improved. Many persons were at first summoned for taking lodgers into unlicensed houses.

In October 1854 a public park was opened in a suburb of Macclesfield, and it has been very largely used by the working classes.

Industrial fluctuations.

In 1860 a considerable depression in the silk trade, which had prevailed for some time, reached its climax, and numbers of people were thrown out of work. Employment was found for them in stone quarries, road making, levelling hills, and other unskilled labour. The distress continued at its height for about three years, during which many people left the town, and others were employed upon public works, but none who could work received public relief except in return for work. In the two winters, 1862 and 1863, the unemployed operatives have been engaged in the construction of a new cemetery which will shortly be ready for use.

Present sanitary state.

The present condition of Macclesfield constitutes a very great contrast to its state as described in the reports of the inspectors in 1849 and 1851. The greater part of the old town may be said to be in as perfect a state as possible as regards its paving, sewerage, and water supply, with the proviso that the old midden system has been retained, but has been reduced to its minimum of offensiveness. A portion of the old township of Macclesfield, with the suburbs of Sutton and Hurdsfield within the borough, has not yet, however, been brought under the operations of the board, but a beginning of works similar to those described in the old town has been made in Sutton. But everywhere cleanliness has been promoted, scavenging has been carried out, water supply of ample amount has been provided, and probably the worst parts of the town are now in a better condition than the best parts of the old town were before the existence of the board. The sewerage works act everywhere efficiently, and though they are incomplete for want of an outlet sewer, the nuisance occasioned by this defect is of manageable dimensions.

There is now no subsoil water above the level of the sewers anywhere, and cellars which used to be flooded are now dried by the sewers. The supply of water is abundant, and continuous by day and night, under pressure sufficing to raise it to the top of every house. The contents of the middens are removed, on no very regular system certainly, but in practice rarely so seldom as once a year; and being kept dry by efficient drainage, nuisance rarely arises from the accumulation. Other nuisances are of infrequent occurrence. Overcrowding does not now exist, and the 30–40 common lodging-houses are clean, decent, and well supervised.

Instances of improvement.

Particular streets visited at the present inspection brought into strong relief the character of the improvement that had been effected. Thus of King Street it was reported, that Mr. Smith in 1849 could not get along it, it was knee-deep in filth and abominations, its houses were filthy, and its courts worse than the street itself. Now it is a clean street, admirably paved and channelled, its houses tidy, cleanly, painted, and respectable looking. A court from it was found well paved, and drains with traps to the sewer inlets; a privy and ashpit to three cottages, in good order and quite without smell. The court houses themselves are singularly clean and tidy considering they are the dwellings of quite poor artizans. In James Street there are some 20 houses that used never to be occupied, for one reason because people could hardly get at them; as soon as the road was made and the houses set right, they were occupied and have been ever since. Landlords and tenants alike catch the trick of cleanliness when everything about the houses is put into perfect order; a little emulation on this point arises and the general improvement in the way of people's thinking in these respects is wonderful, the efficient and constant supervision and scavenging by the authorities serving as an encouragement to perseverance.

Mortality statistics.

The effect upon mortality is shown by the following abstract of the death statistics of the township of Macclesfield, which were analysed specially and independently for the purpose of this report. The township comprises the east and west registration sub-districts which have been examined separately and together. Death rates have been calculated on a population derived from the census returns, but corrected for fluctuations during the intercensual periods. Allowance has been made for the disturbing influence of the workhouse, or a note is given as to any such influence that has not been allowed for.

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Deaths per 10,000 Residents, at all Ages, yearly.	Before (8 years 1845–52)	During 4 (years 1853–6.	After (8 years 1857–64.
	execution of Sanitary Works.		
All causes, all ages, and both sexes - - - -	298	244	237
All causes, under 1 year -	$77\frac{1}{2}$	$70\frac{2}{3}$	$59\frac{2}{3}$
Males - -	43·2	40·0	33·35
Females - -	34·25	30·6	26·25
Epidemic diseases :—			
Smallpox (all ages) - -	$6\frac{1}{3}$	$0\frac{2}{3}$	1
Measles „ - -	$6\frac{1}{2}$	$4\frac{1}{2}$	$4\frac{1}{2}$
Scarlatina „ - -	11	$3\frac{3}{4}$	6
„ under 5 - -	7·35	3·2	4·4
„ over 5 - -	3·7	0·6	1·7
Diphtheria (all ages) - -	$0\frac{1}{11}$	—	$1\frac{1}{3}$
Whooping-cough „ - -	$6\frac{2}{3}$	$5\frac{1}{2}$	5
Croup „ - -	4	$0\frac{3}{4}$	$1\frac{3}{4}$
Erysipelas „ -	$1\frac{2}{3}$	$0\frac{1}{3}$	$1\frac{1}{6}$
Rheumatic fever „ - -	$0\frac{3}{4}$	$0\frac{1}{3}$	$0\frac{2}{3}$
Continued fevers, all kinds, all ages.*	18	14	$8\frac{1}{2}$
„ under 5 - -	3·1	1·6	1·5
„ over 5 - -	15·0	12·4	7·0
Or, after excluding deaths presumably typhus.	$14\frac{1}{4}$	14	$8\frac{1}{2}$
Diarrhœa (all ages) - -	$11\frac{1}{3}$†	$13\frac{3}{4}$†	11†
„ under 5 - -	8·3	10·4	6·1
„ over 5 - -	3·0	3·3	4·8
Cholera (all ages) - -	In all years, stray cases. In 1849 $9\frac{1}{2}$.	In all years, stray cases.	Cases in 3 years only, in 1866, 0.
Dysentery „ - -	3	$1\frac{5}{6}$	$0\frac{3}{4}$
Phthisis, all ages, both sexes -	$51\frac{1}{2}$	39	$35\frac{3}{5}$
Under 5 - -	4·0‡	1·0	0·5
Males, 15–55 -	15·7	12·0	12·1
Females „ -	23·3	20·6	18·15
Other lung diseases, all ages and sexes.	$40\frac{2}{3}$	$49\frac{3}{5}$	46
Under 5 - -	16·1	23·0	19·5
Males, 15–55 -	4·2	3·8	4·1
Females, 15–55	5·1	4·1	3·9
Brain diseases, all ages and sexes.	$44\frac{1}{4}$	$46\frac{1}{4}$	$43\frac{4}{5}$
Under 5 - -	30·3	31·5	27·2
Males, 35–55 -	2·1	1·9	2·4
Females, 35–55	1·3	1·5	2·2
Males, all over 5 - -	7·1	7·2	8·9
Females, all over 5 -	6·7	7·6	7·8

* When correction is made for persons brought into workhouse with fever from outlying parishes, the actual rates become rather less, especially after 1854; the *reduction* would therefore be somewhat greater than shown above.

† Many in workhouse, inmates. ‡ Many uncertified.

A diminution will be observed in the prevalence of every one of the contagious diseases, diphtheria (if it ought to be separated from the previously known disease, croup) being the slight and unimportant exception. Diarrhœa does not here show any reduction, but probably if the mortality among workhouse inmates could be separated, some reduction would appear. But smallpox, measles, scarlatina, and whooping-cough, the most contagious of the ordinary epidemics have all been notably less fatal since sanitary measures were adopted in the town. Fevers too have been reduced, taking the whole town together, to less than one half of their former mortality; and even if the deaths of the epidemic fever years 1857–8 be excluded (as having probably been caused by true typhus imported from Ireland) the fever deaths have still been reduced to nearly the same degree.

Consumption at every age has been far less fatal than before. Other lung diseases, and diseases of the brain do not show any reduction.

In estimating the connexion between the works of sewerage, paving, and nuisance removal on the one hand, and the fall in mortality on the other, several circumstances have to be taken into account. The reduction of overcrowding, by the regulation of common lodging-houses, by the bringing of untenantable houses into a state for habitation, and by emigration from the town through slackness of trade, is a very important consideration bearing chiefly on the facility for spread of contagion; and secondly, the change in occupational conditions through the stoppage of some mills, and the consequent employment of men out of doors, while the women were released from the factories to mind their children at home, cannot be lost sight of. But the former of these considerations is itself a sanitary measure, in a sense not inferior to house drainage and water supply; and the second consideration does not claim very serious notice, inasmuch as the improvement in the public health had begun and had reached a positive extent before any slackness in the staple manufacture of the town was experienced.

Independent illustrations of advantage from works.

Some very striking facts, illustrative not only of lessened mortality, but of improvement in social and moral character of the people are given in several reports of the local board of health. Already, in 1854, a much smaller number of deaths were registered in persons resident in certain streets that had been paved and sewered than in the same streets before such works had been carried out. Not to quote these figures, since the objection may be raised that single years are unsafe for comparisons of mortality, the following statement as to another advantage of sanitary work does not appear open to the same objection:—

Reduction of crime.

"Besides promoting health, it is urged that sanitary measures have a tendency to promote morality and lessen crime, and the board did not hesitate to believe that the change they had effected in places like Wood Street, Nixon's Yard, and Watercotes, must have been some guarantee for better conduct; that, in fact, cleanliness, pure air and water, drainage, and a well-ordered surface, must possess some humanizing tendencies, and it appears that during the last year, as compared with the two preceding years, in these three streets, being the only places selected as standing most prominently in the police records, felonies and other offences have decreased in—

Wood Street - - - -	55 per cent.
Nixon's Yard - - - -	47 ,,
Watercotes - - - -	24 ,,

Whilst in the whole borough there was actually an increase of 4 per cent. in the same period; but in the last year compared with the preceding one, there was a decrease of 4 per cent.; and Mr. Harper, the chief constable, in his last report, stated 'that there had been considerably less

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' drunkenness amongst the working classes during the past year than for ' several years previously.' These figures, viewed in any light whatever, cannot fail to carry conviction in favour of the policy of energetic sanitary measures."

In 1855 testimony to the value of the sanitary works comes from another source. "In the report upon the borough by Mr. Rawlinson there " is a statement quoted showing the number of cases of sickness and " the amount of relief paid in 1848 in several streets, in proof that such " places were maintained at great expense to the poor rates. These " places are now sewered and paved, and the statement presents the " following comparison :—

Reduction of poor relief expenditure.

	" Relief paid in 1848.	Relief paid in 1855.
" Wood Street - -	£54 0 0 - -	£3 18 0
" George Street - -	54 0 0 - -	12 10 3
" Water Street - -	40 4 6 - -	1 0 0
" Nixon's Yard - -	10 1 0 -	7 16 6
	" £158 5 6	£25 4 9

" The cost of the whole of the constructive works in these streets was " 1,541*l.*; and so far as one year's expenditure is a criterion, the saving " in relief would pay the interest on the outlay at five per cent., and " leave 56*l.* as an instalment towards the principal."

Reduction of mortality.

In the report of 1858, five years having elapsed from the commencement of many of the operations of the board of health, and some works being complete, a comparison of the mortality could more profitably be made, and its results (agreeing substantially with the independent inquiry made for this report,) were as follows :—

" Before the operations of the board, the rate of mortality in the borough was 33 in 1,000, for the last five years it has been 26 in 1,000, so that 1,015 lives have been saved. In funeral expenses alone, calculated from the returns of 232 burial clubs, 8,729*l.* are saved. But a larger item would accrue under the head of diminished sickness, there having been 28,420 less cases of sickness, and the cost of these cases being estimated according to the data furnished by benefit societies, at 1s. a day for 20 days, 28,420*l.* would be thus saved. These figures are not taken from any assumed state of facts; the calculations are not made as is generally the case upon the supposed excess of deaths, between the actual numbers dying and the numbers expected to die under circumstances favourable to health, which nevertheless is the correct way to illustrate the degree of health in places where sanitary measures have not been in operation. But here nothing is assumed; two succeeding periods of five years each are contrasted, the one so unhealthy as to produce an average of 33 deaths in 1,000; whilst at the same time and for the same period a rural district of 17 townships immediately surrounding the borough produced an average of only 16 deaths in 1,000. The other period, after the operation of sanitary measures, produced an average of 26 deaths in 1,000, so that the 1,015 lives saved are living examples of the facts here stated. The same is equally true as to the 28,420 less cases of sickness in the last five years as compared with the former. Again, an actual instead of an assumed contrast can be presented with no less agreeable result in the average length of life. The average age of all who died in the first period was 24 years (in the adjoining rural district it was 34 years); in the last five years it has been 27 years. Each year gains an accession, the last year's average being $28\frac{1}{2}$ years. Length of days by three years have thus been added to each inhabitant. A few years ago, statements such as these received but little favour; indeed many people affected to ridicule them; now, however, such vital statistics have assumed an authority which prevents

Longer duration of life.

even the ignorant from questioning their real value and tendency. All the facts are alike conclusive, and point to the same result, and one more will be as intelligible as the rest ; the deaths of children under one year have decreased 16·3 per cent., and those under five years 4·6 per cent.

"The causes of death when contrasted are equally striking. The cause of death is now inserted in the register under the certificates of medical practitioners, and is therefore technically correct. The board have caused every single death to be extracted during each year under the various heads, and the numbers show that the decrease is very much confined to that class of deaths essentially preventable. Zymotic diseases are those which commonly rank under this class, and they have decreased upwards of 27 per cent."

Illustration from localities.

A further experience of the board of health given in their report of 1863 affords very solid ground for connecting the improvement in health with the sanitary works of the board. By this time the data for a statement on this point had become considerable enough to ensure fair freedom from the fallacies attending the examination of shorter periods.

"It is the duty of the board of health to lay before the Council periodical information which is interesting to the public and suggestive as a safeguard to health. In 30 streets which have been sewered and repaired by the board, comprising a population of one-seventh of the whole borough, the death rate has been 15 to 1,000, whilst in the entire borough it is 26 in 1,000. If the 30 streets were compared with the rest of the borough instead of the whole which comprehends the 30 streets, the mortality would stand thus:—the 30 streets sewered 15 deaths to 1,000, the rest of the borough 31 deaths to 1,000. The inducements therefore to live in sewered streets are very apparent, and it must be borne in mind that most of these streets are inhabited by the poorest families, and they are by no means well situated as regards salubrity. It should be stated that the exact population of these streets has been accurately ascertained now, so that the figures may not admit of doubt."

Lastly, it is well to quote from the report of 1864 that all the improvements effected in this town, including the purchase of gasworks and other expenses not connected with the improvement of its sanitary state, "have been done by the board with a rate of 1*s.* in the pound, against 2*s.* 6*d.* levied by their predecessors," and that out of upwards of 70 towns there is not an instance where so small a rate is levied for the same purposes.

NEWPORT, MONMOUTHSHIRE.—Population (1861) 24,756.

NEWPORT.

Mr. Clark was the superintending inspector who in 1849 examined this town for the General Board of Health. The following account of its unimproved condition is almost wholly from his report.

Condition before recent sanitary work.

Newport, though the largest and most important port of the South Wales mineral country, had at that time a much smaller population than at present. It was (on a present estimate) 18,525 at the time of Mr. Clark's report. Mr. Clark only knew that it had been some two-thirds of this at the time of the census of 1841, and was rapidly increasing. Even in 1849 the town had extended considerably in the direction of the docks, but the low-level marshy plain—that between the main town and the outlying part called Pillgwently—was then scarcely at all built over.

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Site.

"Newport is situated on the Usk, 4½ miles above its mouth, standing on the right bank of the river at a point where the hill country sinks down into the broad plain that lines the Severn. The old town lies chiefly between the bridge and the hill of St. Woollos, which rises 196 feet above the river. The Usk is navigable for shipping up to the stone bridge in the town. Pillgwenlly is a suburb on the level of the river, and containing the docks. A canal runs nearly parallel to the river from the docks to the old town.

"St. Woollos hill is composed of old red sandstone. Pillgwenlly is on an alluvial deposit of fine sand, and through this bed, here of great thickness, the channel of the Usk passes below the town. The docks, which were opened in 1842, include a water area of 4½ acres. The natural level of the parts about the docks is from one to four feet below high water of spring tides, and is protected by a sea wall. Shingle ballast has been brought by the tramways that traverse this plain, and thus the whole surface has been raised six or eight feet with great advantage to the site as respects facilities for drainage. Such houses as have been built before this was done are particularly low and damp and are seats of fever."

Management.

"The duties of lighting, paving, cleansing, and maintaining roads are vested in Improvement commissioners who act for the old borough only, which includes about one-third the area, and half the inhabitants (1849) of the present borough." In the lower town any improvement that had been done had been under the Nuisance Removal Act. In the old borough the powers of the commissioners had been found very ineffectual for sanitary improvements, and on any permanent works of this kind they had spent hardly any money.

At the time of Mr. Clark's inspection, very exceptional action had been taken to get the town into a cleanly state on account of the recent prevalence of epidemic cholera. New privies had been erected, old ones cleansed, gutters swept, ashpits emptied, rooms limewhited, and quicklime thrown into the ditches. But the actual condition of the town was seen—beneath this temporary amendment—to be substantially in the same defective condition as for many years it had been.

Particular districts were pointed out in the more crowded and dirty parts of the town as being those where fever was always present, and where other epidemics took an exceptional degree of malignity; these were in the neighbourhood of private streets and unfinished roads, over which the local authorities had exercised no control. A great epidemic of dysentery had just passed over the town, selecting as usual these spots; and cholera had been distributed in the same course.

Sewerage.

"Newport is very insufficiently sewered. Parts of the town are without any sewers at all, and in others the sewers are intended solely for the removal of surface water, the householders being strictly forbidden to drain into them. It is, of course, impracticable to enforce in all cases such a prohibition, and in consequence the large untrapped gates of such sewers give out most offensive stench in the streets, and their contents render the waters of the canal, into which many of them discharge, very impure.

"Although the fall of the upper, or northern, part of the town is excellent, that of the lower part, across which the upper drainage is in a great part led, is very defective, and the drains being under high-water level, can only discharge in certain states of the tide." *

* The following are samples of conditions commonly met with by Mr. Clark :—

"The summit of the town is very imperfectly drained and very badly supplied with water. Here, in one of the best situations of the town, is a group of cottages built back to back with rising ground above them. The want of back windows renders the rooms very close. There are two privies to the whole, which discharge into an

Instances of deficiency in this respect may be found in the subjoined note. "The inferior class of houses are without any kind of house "drainage. Slops and refuse are thrown into the privy when there is "one, or more commonly into the open street." Even in the old borough the surveyor had found it impossible to keep the streets decent by any amount of scavenging, and in the outlying parts towards Pillgwenlly there were not even public arrangements for the removal of refuse from the streets. Nor did the control of the commissioners extend to any private streets or courts, which were consequently found either unpaved or very badly paved and with serious accumulations of filth. The surveyor gave the following account of the first operation of the Nuisances Removal Act, 1848 :—

Nuisances.

"As surveyor, the Improvement Act gave me no summary power over private nuisances; but upon being appointed agent to the sanitary board under the Act for 'the more speedy Removal of Nuisances,' I had an

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open ditch. The cottages have no water." A court, "but partially paved. Nine houses, of which six are without back windows or efficient drains; two privies without drains; people dependent for water on a distant pump."

"Commercial Street contains 176 houses, and forms part of the great street of Newport. On the west side most houses have proper drains terminating in a sewer which falls into the Pill. On the east side the houses drain upon the low ground towards the canal, and, the fall being deficient, a serious nuisance is produced. Much of the semi-fluid ordure that affects Friars' Fields comes from this source. The canal is at present a great obstacle to a perfect drainage. Further on, close to the road, are some open ditches, stated to receive house drainage. The culvert along this road is only intended for surface water, and to drain the low-lying tract so as to allow it to be built on.

"Friars' Fields include a considerable tract of land between Commercial Street and the river, and, though low, quite capable of being drained. This ground has been built on many years. These fields are neither paved nor macadamized; the rain-water stands in pools on the surface. This place is always in a most filthy condition, and one of the chief evils existing there is the keeping of pigs in small confined yards with no drainage.

"This whole tract of ground is indeed at present in a very discreditable state. Here are courts within courts, close, damp, and very filthy, with typhus in an aggravated form continually breaking out. Davies' Court is a cluster of houses. Rees' Court is particularly close. The barrack is very foul. The cholera began here.

"In Irish Row are 22 houses; three of them are built up against three others in front; six have backyards, but no drains to take off the surface water, which flows into the houses; these houses are each inhabited by several families; each family takes a room and then sublets it. They are very much overcrowded. There is not a single privy to any of the houses. The street is at all times full of pools of water, and in the winter time almost impassable!

"In Fothergill Street there are 21 houses, several consisting of four or five rooms, occupied by separate families, and again sublet by them to eight or ten, or sometimes 12 to 14 persons, nearly all Irish, having but the limited accommodation of one room, in which they all sleep, in beds made of shavings and rags, on the floor, with windows closed and the fire-places stopped up, breathing the same atmosphere over and over again; this very room having been used for all household purposes during the day."

Towards Pillgwentlly the state of matters was almost worse :—

"Jones' Court is one of a series of courts along the course of the Monmouthshire Canal Railway, in which cholera prevailed. They stand on the original very low level of the ground; the fronts are entered from the first floor, and behind is an entry on the ground floor, both being tenanted; these lower rooms are low, damp, filthy, and unhealthy. The rent is 2*s.* 4*d.* a week for one room and two cupboards used as bedrooms. There is a public refuse pit in front. The public privy here is in a dangerous condition and very filthy.

"Temple Street contains 27 houses without drainage or efficient gutters. The overflow of the privies escapes into the earth; ordinary house refuse is cast into the open street, the surface of which is incomplete and full of holes.

"Granville Street.—These houses have been lately built. Those on the left hand side of the street have drains from each into a culvert. The yards are too small, close and confined. Privies, but no dust-bins or other convenience for domestic refuse, and situated where there is no system of scavenging, the people are consequently compelled to throw their ashes out into the street The houses on the other side are better situated, but have no culverts or drains."

an opportunity of discovering nuisances of which I had previously slight conception; holes intended for cesspools at slaughter-houses, with light coverings, in densely populated localities, the sediment being but seldom removed, and in many places waggon loads of filth accumulating in small yards adjoining slaughter-houses, privies heaped up, and holes of stagnant water, pigsties filled with pigs, seldom cleaned out, and situated in confined backyards, adjoining the doors and windows of their owners.

"On being appointed by the sanitary board, we lost no time in commencing our arduous duties, and in the course of nine weeks had the satisfaction of knowing that thousands of loads of filth had been removed from the town; waggons and carts in all directions being engaged, night and day, carrying away the refuse from slaughter-houses, pigsties, cesspools, and holes; but without the greatest vigilance the same nuisances will of necessity perpetually recur, and the evil will be repeated until the cause be removed."

Water supply.

Mr. Clark reports that "Newport derives its water from rain, from wells and pumps, and from waterworks." The first two sources were scanty and frequently impure. For ordinary purposes many cottages had recourse to the canal, the water of which was befouled by sewage.

"The Newport and Pillgwenlly waterworks were established by Act of Parliament in 1846, and completed 1848. The main reservoir is $1\frac{3}{4}$ miles distant from the town. It covers 14 acres, contains 146,000,000 gallons, and its top level is about 80 feet above high-water mark spring tides.

"From the storage reservoir the water is led by an iron conduit pipe of 12 inches in diameter to the lower service reservoir upon Stow Hill. This is lined with masonry, and contains 158,000 gallons. Its top-water level is 66 feet above high-water mark. From this tank water is forced up by steam power into the second service reservoir on the top of Stow Hill, also lined with masonry, and containing about 50,000 gallons. The top level of this reservoir is 196 feet above high-water mark. The engine will lift about 170 gallons a minute, an ample supply for the limited number of houses, about 200, which from their elevation might require to be supplied from the upper reservoir.

"Setting aside the upper reservoir and its area, it appears that the company possess a storage of nearly 150,000,000 gallons at an elevation capable of commanding nine-tenths of the town, the population of which cannot be much less than 15,000 persons; so that, supposing a daily consumption of 20 gallons a head, the storage would be sufficient for 500 days; a supply, therefore, quite sufficient for every possible want, public or private, of the town of Newport, even were the numbers of its population more than doubled."

The arrangements of the company were for supply on the constant system, but the advantage presented by these waterworks were very scantily used by the owners of cottage property. Out of 830 houses rated under 10*l.*, 25 only were supplied with the company's water.

Sanitary works.

From the condition of things described by Mr. Clark, Newport has since made much progress, but in numerous ways there is room for further improvement. The following is the chief action that has been taken by the authorities since the application (to the entire borough) of the Public Health Act.

Sewerage.

A scheme of drainage has been carried out for the whole borough. In this, existing sewers were made use of as far as practicable. The sewers are large and deep and receive storm water as well as house drainage. There are six or seven different outlets discharging into the river, the enormous tide in which presents injurious accumulation on the banks; the outlets are protected by tidal doors, but when a storm occurs during high tide, water accumulates in the sewers and is backed up a considerable distance, even flooding the cellars of low-lying parts. The

size of the chief sewers is $4\frac{1}{2}$ by $3\frac{3}{4}$ feet, and some are square, 5 or 6 feet. Many of the mains are nearly on a level or with only 1 in 400 incline, and matters are apt to deposit in them in dry seasons. They vary from 6 to 15 feet below the surface of the ground; but everywhere are deep enough to drain cellars. For the most part sewers whose fall is bad are kept pervious by the quantity of storm water that flows down them and by the springs which they intercept at the upper parts of the town. The smaller sewers have generally the better incline, but some of these have needed special arrangements for flushing by the company's water. Some of the old sewers, however, that are laid without proper inverts or cement are apt, however, in the course of years, to get choked in spite of all precautions. The sewers are ventilated by leaving the manholes in the streets untrapped (charcoal trays having latterly been used experimentally to certain of such openings), and formerly by a special shaft at the highest part of the town, which was abolished because of the nuisance caused from it to a well-to-do neighbourhood when the outlet was closed by the tide or the wind set up the sewers. The submains are of brick down to 14-inch barrel drains, and with these the house drains are connected by 6, 9, or 12-inch pipes, having their inlets and side gullies carefully trapped.

The dates of the main sewerage works are from 1856 to 1859, when all were completed and the chief number of houses had been drained.

Extension of water supply.

The supply of water to Newport remains in the hands of the same company, but their operations have been much extended. The water is soft, being got from mountain springs beyond the reach of organic contamination. The water is not filtered, but there appears to be little need for that; slight turbidity is observed, however, as an exceptional condition. In 1854 some increase in the supply was made, especially to the high service. For the lower parts of the town the supply is constant by day and night, except in certain seasons of drought, and is delivered now into every court by screw taps. It is not laid on within the houses of poor parts. To districts where the supply requires to be pumped, the water is delivered in the day time only. The amount delivered is not exactly known, but probably averages nearly 20 gallons a head per day.

Waterclosets are provided with service cisterns in better-class houses, but outside closets seldom have water laid on to them; a bucket full is supposed to be drawn from the nearest tap to flush out the pan of the closet after using. Upon actual inspection every possible variety was found in the way people did this duty; many privies were found choked, and in an extremely filthy condition.

Paving.

Paving and road-making are works that the board of health have had carried out on an extensive scale; besides the public streets in the older parts, most courts have been paved or macadamized. But it must be stated that over considerable areas there is deficiency in this respect. The roads of the newer parts of the town, those which have grown up between the old borough and Pillgwentlly, have been set into really good order as soon as works of drainage were completed, but here, where the soil has been artificially made of loose ballast, the roads are apt to get out of order through the settling of the ground.

Effect of Sewers.

The effect of these various structural works upon the dampness of the town has doubtless been considerable. Though, in the upper portions, any springs that did exist continued to run, and though many of the low-lying parts were built on a stratum of impervious alluvium, there remain large tracts, chiefly where the ground had been made by ballast, where a good deal of subsoil drying has been effected; and as far as the works of paving and channelling have gone, they have substituted a dry for a sloppy and foul surface. The effect of the drainage in removing excreta from the town has also been great, but certainly not yet

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universal, for some cesspools are left, and the inhabitants are by no mean cured of their old habit of disposing of excreta on the surface; indeed, many closets are in a condition to make the roadway a preferable place of defæcation.

Ashes and house refuse are removed by contract. They are brought outside the houses on two days of the week, when the contractor's cart traverses the street, and attention by the tenants is enforced by fines.

Lodgment.

Little has been done in improving the condition of houses. However dilapidated or unwholesome a house may be, unless the owner can be persuaded to stop letting it, there is little chance for the local board to get it shut up. Proceedings to close houses unfit for habitation have been taken, but the magistrates, through their clerk, have put such obstacles in the way of this action, that it has been desisted from; and the lodgment of the people remains much as it was before the operations of the board, with the exception of such changes as occur through the population fluctuating with the amount of employment. As an example of this kind of change, there was in 1858 far more crowding than a few years later, when labour became less in demand, and many houses stood empty. As regards new houses, there are regulations for their construction which have obtained due space and ventilation in them; but the rules have not been very strict, inasmuch as no one will build any but cheap houses on the short leases that are to be had, and the board desired not to enforce rules that should amount to a prohibition of building. The corporation has lately, as the leases have fallen in, demolished some of the worst houses on their own property.

Twelve common lodging-houses have been regulated, and appear in good order. It is in sublet houses of other kinds that the worst conditions of lodgment exist. In Friar's Fields, an old opprobrium of the town, a number of most ill-constructed houses, doomed shortly to be taken down by the corporation, were found extremely ill-ventilated, and many of them overcrowded to a serious extent. Cases were noted of persons living in the same room day and night with less than 100 cubic feet a-piece. Overcrowding proceedings have in two instances only been taken.

spection.

The statement has almost been anticipated that Newport stands at present in urgent need of better sanitary inspection. In 1862, Dr. Davies was appointed medical officer of health, and has done good service in that capacity. But for the duty of inspecting courts, privies, and houses, he has only a fraction of the time of one inspector put at his disposal. In this town, too, more than in most, ample inspection is wanted, as means of amendment are not habitually enforced off-hand by willing magistrates.

Want of provision for infectious disease.

Before proceeding to sum up the mortality statistics, mention must be made of the want of provision in this large town for the proper isolated treatment of infectious disease. The recent prevalence of typhus fever has brought this defect into strong relief. The alternative is to leave a typhus patient in a crowded room (under circumstances which have in one instance operated to cause eight deaths in one small house) or to remove him to the workhouse, where he is (if it is possible that my notes, derived from an authentic source, can be trusted on the point) warded along with accidents and lying-in women, the beds almost touching each other, and the sexes being separated by a curtain only. Happily only one case of typhus had occurred in a common lodging-house.

Statistical inquiry.

The mortality statistics of Newport have been examined for the subdistrict, whose boundaries are not precisely the same as those of the borough, including parts of the parish of St. Woollos that are extra-municipal, and not including a small district thinly inhabited lying within the borough on the distant side of the river. But for the present purpose the difference of boundary is unimportant. Moreover, no

correction could be made (except in the totals) for persons not belonging to the borough dying in the workhouse within the borough, as no record of the cause of their deaths was available. But no error of appreciable magnitude can arise from this omission.

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Per 10,000 of total Population yearly.	Before any Works (5 years, 1845–49).	After Water Supply and some Inspection (7 years, 1850–56).	During Main Drainage Works (3 years, 1857–59).	After Main Drainage and Water Supply (6 years, 1860–65.)
Deaths from all causes, all ages - - - -	318	226	229	$216\frac{1}{2}$
Or, excluding cholera and Irish dysentery - -	$283\frac{1}{4}$	226	229	$216\frac{1}{2}$ (here 1866 included.)
All causes, under 1 year -	$67\frac{1}{4}$	64	$58\frac{2}{3}$	$53\frac{1}{4}$
Males -	33·3	36·1	30·3	28·2
Females -	33·9	27·9	28·3	25·0
Epidemic diseases :—				
Smallpox, all ages -	15	$4\frac{1}{2}$	9	$4\frac{1}{3}$
Measles ,, -	6	$6\frac{1}{3}$	4	4
Scarlatina ,, -	$9\frac{3}{4}$	$8\frac{2}{3}$	$12\frac{1}{4}$	$11\frac{1}{3}$
Diphtheria ,, -	—	$0\frac{1}{3}$	$2\frac{1}{2}$	1
Whooping cough ,, -	$8\frac{1}{4}$	7	$7\frac{1}{3}$	$4\frac{1}{4}$
Croup ,, -	4	$3\frac{1}{2}$	$4\frac{1}{3}$	$4\frac{1}{4}$
Erysipelas ,, -	$2\frac{1}{4}$	1	1	$0\frac{3}{4}$
Rheumatic fever ,, -	$1\frac{1}{3}$	1	$1\frac{1}{4}$	1
Ague ,, -	$0\frac{1}{5}$	$0\frac{1}{4}$	$0\frac{1}{10}$	$0\frac{1}{10}$
Continued fevers ,, -	$33\frac{1}{3}$	13	$12\frac{1}{4}$	$10\frac{1}{3}$
Typhus epidemics ,, -	($84\frac{1}{2}$ in 1847)	—	—	(40 in 1866)
Typhoid fevers &c. excluding *typhus*, 1847, all ages.	$16\frac{1}{3}$	13	$12\frac{1}{4}$	$10\frac{1}{3}$
0–5 - -	4·2	3·4	2·5	2·8
5 upwards -	12·2	9.5	9.9	7·6
Diarrhœa, all ages -	11	$6\frac{2}{3}$	9	$6\frac{1}{2}$
Under 5 -	8·5	4·7	8·0	5·5
Over 5 -	2·6	1·9	1·0	1·0
Cholera, all ages -	(In1849,$111\frac{3}{4}$)	(In 1854, $1\frac{1}{2}$)	—	(In 1866, 12)
Dysentery ,, - -	12 (Irish epidemic 1847–9)	$2\frac{1}{3}$	$0\frac{2}{3}$	$0\frac{1}{2}$
Phthisis, all ages and both sexes	37	$29\frac{3}{4}$	27	25
sexes:—Males, 15–55 -	15·4	10·8	9·7	10·6
Females, 15–55	11·4	11·4	12·2	9·9
Lung diseases, all ages and both sexes.	$37\frac{1}{3}$	$35\frac{3}{4}$	26	32
0– 5, both sexes	20·0	20·4	15·7	16·1
15–55 males -	6·3	5·0	2·7	3·1
15–55 females -	2·6	3·0	1·5	2·7
Over 55, both sexes	7·1	6·5	5·7	9·5

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NEWPORT.

Per 10,000 of total Population yearly.	Before any Works (5 years, 1845–49).	After Water Supply and some Inspection (7 years, 1850–56).	During Main Drainage Works (3 years, 1857–59).	After Main Drainage and Water Supply (6 years, 1860–65).
Brain diseases, all ages and both sexes.	$49\frac{1}{3}$	$43\frac{1}{2}$	$38\frac{1}{4}$	$30\frac{3}{4}$
0– 5, both sexes	36·9	32·3	26·8	19·5
5–35, „	4·7	3·8	3·6	3·2
35–55, „	2·7	2·2	3·2	2·7
55 upwards „	5·0	5·2	4·6	5·4

Deaths from all causes in Newport have declined from 318 to $216\frac{1}{2}$ in the 10,000. In taking these rates full allowance has been made for what can be estimated of fluctuations in population. Even if all cholera epidemics be excluded, the reduction remains very considerable. The death rates have been grouped for four periods, the first before 1850, when, for the first time, water began to be extensively supplied to the town: the death rate then was 295, excluding cholera. The second, from 1850–1856, a period when plenty of good water was available, and the removal of more flagrant nuisances was obtained: the death rate then was 226 in the 10,000, and, excluding cholera, 225. The third period was during the construction of the sewerage works, from 1857 to 1859, when the rate remained about stationary at 229: this period would coincide with that of maximum population in Newport. And, lastly, since the town has got the benefit of its sewers, in addition to the other improvements previously introduced, a time, too, during which the crowding of houses has been less intense: in these last years the rate has been reduced to its lowest, having averaged $216\frac{1}{2}$ in the 10,000.

The reduction in mortality in children under one year of age has followed about the same rule as at other ages. The deaths of such numbered $67\frac{1}{3}$ (per 10,000 of total population) before improvements were begun, and 63, $58\frac{1}{3}$, and $53\frac{1}{4}$ are the successive figures of the three subsequent periods.

Of the more contagious epidemics, small-pox, measles, and whooping-cough have been reduced in fatality; measles from the end of the second period, whooping-cough only of more recent years. Scarlatina, on the other hand, has increased, though not to the same degree as in Merthyr and Cardiff. Diphtheria has appeared newly on the registers, and has given a moderate (for South Wales a small) mortality. Croup has been returned as a frequent cause of death, rather more in the later than in the earlier periods under review. Erysipelas, to which a somewhat large number of deaths used to be ascribed, is now seen on the death registers only one-third as frequently, population for population. Fevers were returned in the period before 1849 as a more frequent cause of death in Newport than in any other town that has been visited for the purposes of the present inquiry, no less than $33\frac{1}{3}$ per 10,000 annually having died from the diseases grouped under this name. Of these it may be reckoned that fully half were contributed (during 1847 only) by Irish typhus; $16\frac{1}{3}$ per 10,000 will then represent the annual typhoid death rate before the earlier sanitary works. After the new water supply was given, and nuisances in part removed, this number fell to 13, then during the execution of sewerage works to $12\frac{1}{4}$, and in 1860–65 it has averaged only $10\frac{1}{3}$ per 10,000. In 1866 Dr. Davies reports that typhoid has been less prevalent still, and that it is

almost wholly to typhus that the large fever mortality of the year has been due. Diarrhœa has declined both among infants and older persons; its decrease dates from the earlier time of water supply and nuisance removal. Since the Irish epidemic of dysentery in 1847–8–9 no recurrence of that disease in its epidemic form has been observed. Cholera in 1849 caused 112 deaths per 10,000. In 1854 the town had got its better supply of water, and was kept more cleanly. Its mortality from cholera was then only $1\frac{1}{2}$ in the same number of population. But in 1866 it has attacked the town rather more severely, and caused 12 deaths in the 10,000.

Before any sanitary works were done the death rate from consumption stood at 37 in the 10,000, of which number $26\frac{2}{3}$ were in people at working ages. These numbers fell in the years following 1849 to $29\frac{1}{2}$ and $22\frac{1}{2}$, afterwards to 27 and 22, and since the drainage works have been in action to 25 and 20. Males appear to have profited more than females by the reduction :* in females, reduction has only occurred in the last of the four periods. Other lung diseases have undergone a slight decline, which is most conspicuous among children. Brain diseases also appear by the registers to have been reduced, but this is solely from the smaller number of children's deaths entered under the (generally unmeaning) names of fits and convulsions.

DOVER.

BOROUGH OF DOVER.—Population, 1861 (without military), 23,108.

The Borough of Dover was inspected for the purposes of the Public Health Act by Mr. Rawlinson in 1849. From his report the following account is condensed.

Condition before sanitary work in 1853.

The town is built to accommodate itself to the form of the cliffs and shoreline, and has a concave front towards the sea; part of the town has now extended up the valley of the Dour, principally on its western side, and many new houses have been built on the beach to the east of the harbour, being an extension of the town towards and under the castle cliffs. Some portions of the town stand high and on a good incline, but the site of the old town and its eastern extension is flat and low, having little elevation above the sea at high water. The old part of the town is also irregular in plan, and the streets are narrow; the site is in some portion even under high-water level of an extreme spring tide. These low and flat portions are flooded when heavy rainfall takes place at the top of high water. This must naturally be the case, and no remedy will prevent this flooding other than pumping off the surplus water at all such times.

Site and soil.

" The district around Dover is on the lower chalk, which presents

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* Dr. Davies suggests that the cause of this may have been the change of employment given to many of the males of the labouring classes in the construction of new docks and in work about them.

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towards the sea bold and precipitous cliffs. Most of the present town and harbour are constructed on an accumulated beach thrown in by the action of the tide, or the land has been reclaimed by the harbour walls and piers. But the coast generally is what is termed by geologists a 'wasting shore.'"

Government.

Various Acts of Parliament were in force for paving, cleansing, and lighting Dover, and the more recent ones (George IV. and William IV.) contemplated the removal and prevention of nuisances, and the further improvement of the town. These Acts were administered by Commissioners, whose powers in many important respects appear to have been limited.

Water.

Respecting the water supply of Dover, Mr. Rawlinson writes :—

"Dover is at present partially and most imperfectly supplied with water from several independent sources. There are two waterworks, and there are also public pumps, water-carts, private pumps, and private wells.

"The waterworks are known as the West Dover Waterworks, situate in Limekiln Street; these are the property of Mr. Joseph Walker; and the East Dover Waterworks, belonging to the Gas Company, which are situated close to the gasworks. Both pump from wells sunk in the chalk; both are limited in their operations to the best class of houses, and neither are capable of supplying the houses in the higher parts of the town. Complaints were made that the water from the West Works had been tainted with oil, and it was proved in evidence that an oil barrel or vat had burst and allowed the oil to run into the well. The water at the East Works is raised into a tank or reservoir in the face of the adjoining cliff, 74 feet above the level of the sea. The engineer could not tell the quantity supplied or the price charged, but he stated that the works could yield about 100 gallons per minute, and that they were preparing to increase this quantity. Neither works have an Act."

"There is a market pump, from which the houses of the surrounding districts are supplied, and the sailors from the harbour also resort to it. During the summer of 1848 it was surrounded by the sailors for hours at a time, to the exclusion of every female belonging to the town.

"The private pumps and wells were in general complained of; some were said to rise and fall with the tide, and were consequently brackish; others were said to be foul and unfit for use by infiltration from cesspools and graveyards."

Sewerage.

"There is no general and combined system of sewers and drains in the town and suburbs. Isolated sewers and drains do, however, exist, but even these are frequently most imperfect in form, arrangement, and size. Many of the best houses stand over a cesspool or cesspools, into which all the refuse of the house and waterclosets is passed. The cottages generally have an open tub placed under a privy seat, and this is emptied at intervals, during the night, into a scavenger's cart sent round the town for the purpose of removing such accumulations."

As an example of the conditions of such sewers as did exist the following account was furnished to Mr. Rawlinson :—

"A brick sewer commences with an internal section 2 feet high by 1 foot 8 inches wide, passes under a house in Oxendon Street with an increased section of 3 feet high and 2 feet in width, crosses the road, and increases to 6 feet high and 4 feet wide, of which dimensions it is carried under 10 houses, when it is diminished to 3 feet in height and 1 foot 6 inches in width, the sides are vertical and arched over, but the bottom is wholly in ruins. This sewer passes into an immense brick vault under Hawkesbury Street, 30 feet wide and 8 feet high, with a rugged bottom of the natural earth, which is covered to the extent of 1 foot in depth

with decomposing filth of the most noxious and dangerous nature. The first outlet from this vault is 5 feet 6 inches high and 3 feet wide, which is diminished to a barrel drain 18 inches in diameter, and is finally continued under a portion of the dock works by a square iron funnel down to low water line, where a clumsy iron flap is attached, originally intended to prevent the tide flowing up the drain, which purpose, however, it does not answer, as every tide passes freely up, and stands at times 6 feet deep under the houses in Hawkesbury Street. The soil in the sewer is also driven back to the upper end, and the offensive smell up the collateral drains through the gully grates into the streets. This is the main drainage of the pier end of the town. The gases generated in this sewer are of such a nature that when the foreman passed through with me the silver watch in his pocket was turned to a mahogany colour. The effluvium from this place is constantly evaporating, and every tide forces it up through the street and yard grates of the district."

Abundant complaints were made to Mr. Rawlinson of the flagrant nuisance and expense of cesspool emptying, and of the offensive and troublesome character of the arrangement for emptying privy tubs.

Privy arrangements.

" This apparatus consists of an open tub, placed under a privy seat, the evaporation from which is constantly passing off. A cart is sent round in the night by the town authorities to remove the contents of these tubs, which have to be carried through the house in many instances ; and the great complaint is the great expense of sitting up, burning coal and candles, until past midnight, waiting for the cart, then having to pay the nightman a penny or twopence *not to forget to call*, and the smell of passing the tub through the house was said to be most offensive. One female, a labourer's wife, stated that she frequently had to set doors and windows open to drive out the stench before she could go to bed. The surveyor stated that the number of tubs in use might be from 300 to 400 but that no more than 100 were removed with anything like regularity ; the others were emptied by the people on to the nearest midden, or out into the street channel, or over the nearest waste ground or open space."

Paving.

" No uniform and regular system of street pavement or road formation has been adopted in Dover. The greatest portion is said to consist of boulder paving ; squared sets have recently been laid down in some main streets, and there are two or three qualities of flint and stone used for macadamized streets and roads."

Nuisances.

The burial-grounds of the town were found in an offensive condition and presumably contaminating certain wells ; yet interments were still taking place in them. Slaughter-houses were in crowded neighbourhoods and ill kept. Pigs " are to be found in various parts of the town, in most " objectionable places ; close crowded upon human habitations, damp, " confined, dirty, and creating a most disgusting nuisance." The common lodging-houses of the town were unregulated and in a bad state, both as regards space and decency.

Recent sanitary work.

Works for improving the sanitary condition of Dover were begun in 1853, soon after the constitution of the Local Board of Health. A contract was entered into for supplying the whole borough with sewers and water. The main drainage and waterworks were finished everywhere in 1856, and a great deal of house improvement was done *pari passu* with those works. But some houses remained unconnected with sewers and unsupplied with water until the last year or two. At the present time (1866) only some new houses and some 50 or 60 houses in the pier district are in want of drains and water.

New sewerage.

The plan of sewerage has been to retain the old sewers to carry off

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storm water, improving and extending them where necessary, but to divert from them all soil-drainage into a new system of sewers that are chiefly pipes. This pipe system discharges into the sea at low water by gravitation. Arrangements were made for pumping it during high water, but inasmuch as the tide, though it rose in the sewers, did not flood the cellars or streets, the pumping was given up as unnecessary. In the present year (1866), however, owing to the increased number of houses recently connected, the sewage has not got off by gravitation, and in spring tides cellars have been flooded. For about two weeks each month, therefore, in the present autumn pumping has been had recourse to.

The great majority of the sewers are 9 to 18 inch pipes, houses being connected by 6-inch pipes, and the block system being largely used; surface water from roofs and yards enters these pipes as well as closet and house refuse. The main valley sewer is brick $4\frac{1}{2} \times 3$ feet, and is laid at a varying gradient from 1 in 280 to 1 in 640, and at a depth of 14 feet below the surface. The pipes are at various gradients, and some of them are only about 6 feet below the surface, just deep enough to drain basements. Waterspouts are left untrapped, when in safe situations, to serve as ventilators. At the summit of every sewer a flushing well is constructed that can be filled from the water-mains ; this arrangement is frequently used and acts efficiently, the sewers being really kept in practice free from deposit.

Its effects.

The effect of the sewerage operations on the subsoil water of Dover has been partial only. Some removal of that water has certainly been effected, inasmuch as in the valley of the Dour much spring water was intercepted, and the invert of the sewer is always a foot deep in such water. And, again, the cellars have been much less flooded than before the sewerage works. But over much of the low-lying portion of Dover there is a special cause of wetness of the subsoil that has been but little affected, in the backing up of springs by the tide, many of such springs being brackish, or acting only at the time of high water. In some thickly-peopled parts of the town situated on sea-shingle, or river gravel, there could be—in the absence of extensive pumping, at any rate—very little alteration in the subsoil water through the action of the new sewers. The removal of excreta and house-refuse water by the pipe sewers appears to be complete, though it is only for the last two or three years that this has been effected so extensively as at the time of inspection.

Water supply.

The water supply of Dover is now mainly furnished by the works of the local board constructed in 1853-56. The water is derived from two communicating wells sunk into the chalk, 226 feet deep, with an adit of 250 yards driven horizontally to intercept springs in the chalk. From these wells 50,000 gallons an hour can be raised, which would amount in practice to 8,000,000 gallons a week. 7,500,000 gallons is, however the average amount really raised, giving to the houses that are supplied the copious allowance of 48 gallons per head per day. From this estimate, however, a deduction would have to be made for water used in flushing sewers, and a little used for trade purpose, and at the Castle.* About 3,600 houses are now supplied with the town's water. The delivery of the water is from two service reservoirs, the higher at 220 feet above low-water mark, holding half a million gallons ; the other (constructed only three years ago) at 145 feet above low water, and

* One of the old companies still exists and supplies 450 houses, chiefly at some high level parts of the town where the town water does not reach. The railway is supplied by its own pumps. So are the barracks on the heights.

holding 1,000,000 gallons, for the supply of lower levels. The water is delivered on the constant pressure system, during $10\frac{1}{2}$ hours of each day. and it is intended to make the supply constant during the night. The water contains $13\frac{3}{4}$ grains of earthy carbonates, and $4\frac{1}{4}$ grains of alkaline nitrates, but is perfectly free from organic matter.

Water is supplied to poor houses by a tap on the main, either inside, or just outside the house. Better class houses usually provide themselves with a cistern for domestic use during the hours the water mains are not charged.

Closets.

Waterclosets have multiplied greatly of late years, not only from the conversion of old privies, but by the new supply of conveniences to houses and courts that were before deficient in respect of them. They are placed outside houses of the poorer class wherever there is a back outlet to the house. The closets are fitted with ordinary pans and siphon traps, and the water is laid on direct from the main. In the low levels of the town, there being large service pipes and good pressure, capital flushing power is obtained, but acknowledgedly at the cost of much waste. The use of service-boxes to waterclosets is gradually being introduced.

Paving and cleansing.

The streets of Dover are now fairly paved and channelled. There is not a great change in this respect from former years, but the old boulder paving has been a good deal replaced by macadam. Private courts are not always satisfactorily paved, even now. The arrangements for street cleaning appear to work satisfactorily. Dust and ashes are removed by a contractor, the ashes being usually collected in moveable boxes, and placed at the house door for him. There is some little tendency observed for people to collect their ashes and sell them for a small amount to private dustmen. Pigs have been got rid of out of the town. Slaughter-houses have been brought into decent order. Interments in the burial-grounds within the borough have ceased.

Lodgment.

There is no notable overcrowding in Dover. Any little that may exist would be caused by the London and Chatham railway having pulled down a large number of houses in the old part of the town. But in the main, this was met by the construction of new cottages that went on rapidly at the same time in the outskirts. Special inquiry made by the surveyor as to over-crowding failed to detect this nuisance. No houses have been shut as unfit for habitation. No means of improving the ventilation of ordinary houses have been adopted, and those which are built back to back remain as defective as ever in regard of ventilation. There are not many houses so sub-let as to warrant a systematic examination of the houses throughout the town. A house may be shared by two families, but of tenemented houses, in the sense of London and large towns, there are none. There are only three common lodging-houses now in Dover which are seen to by the inspector of the board. No rules have been laid down for their management, but they are found decently kept, and not crowded.

The military in Dover barracks have been much increased in number since 1856. They constitute a class very much by themselves, and have been wholly omitted from consideration throughout the present inquiry, and in the statistics that have been obtained respecting the borough population and mortality.

Statistical inquiry.

The mortality of Dover has been investigated for the borough exactly. Mr. Cross, the clerk of the guardians, having been so good as to give his local knowledge to extract from the registers of three sub-districts such deaths only as occurred in residents within the borough, and having made correction for deaths of persons in the workhouse who did not belong to the borough.

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Per 10,000 of total Population yearly.	Before (11 years, 1843–53).	During (3 years, 1854–6).	After (9 years, 1857–65).
	execution of Sanitary Works.		
Deaths from all causes, at all ages - - - -	$225\frac{1}{2}$	207	209
Or, excluding cholera deaths -	$221\frac{1}{2}$	$203\frac{1}{2}$	209
All causes, under 1 year -	$47\frac{3}{4}$	$42\frac{3}{4}$	$46\frac{1}{3}$
Males - -	27·5	25·1	26·5
Females - -	20·3	17·7	19·9
Epidemic diseases :—			
Smallpox - - all ages	3	—	$4\frac{1}{4}$
Measles - - ,, -	$3\frac{2}{3}$	$3\frac{2}{3}$	$5\frac{1}{2}$
Scarlatina - - ,, -	9	$11\frac{1}{2}$	$3\frac{3}{4}$
Diphtheria - - ,, -	—	—	$3\frac{1}{2}$
Whooping-cough ,, -	$5\frac{2}{3}$	3	4
Croup - - ,, -	$1\frac{1}{3}$	$0\frac{1}{2}$	$1\frac{1}{2}$
Erysipelas - - ,, -	1	1	1
Rheumatic fever - ,, -	1	$0\frac{1}{3}$	$0\frac{3}{4}$
Ague - - - ,, -	$0\frac{1}{10}$	—	$0\frac{2}{10}$
Continued fevers probably no typhus ,, -	14	$9\frac{2}{3}$	9
under 5	3·6	2·4	2·3
over 5	10·4	7·3	6·6
Diarrhœa, all ages - -	$9\frac{1}{2}$	13	7
under 5	6·8	6·7	4·8
over 5	2·7	6·3	2·2
Cholera, all ages - -	(In 1849, $40\frac{1}{4}$)	(In 1854, 10)	(In 1866, $4\frac{2}{3}$)
Dysentery ,, - -	$0\frac{2}{3}$	$0\frac{1}{3}$	$0\frac{1}{6}$
Phthisis, all ages and both sexes	$26\frac{1}{3}$	19	$21\frac{1}{4}$
Males, 15–55	10·3	9·5	8·7
Females, 15–55	11·0	6·8	9·1
Lung diseases, all ages and both sexes.	$28\frac{2}{3}$	27	$32\frac{2}{3}$
0–5, both sexes -	12·2	12·0	13·0
15–55 males -	2·8	3·0	3·2
15–55 females -	2·4	1·5	2·1
Over 55, both sexes	10·3	10·3	13·7
Brain diseases, all ages and both sexes.	$32\frac{2}{3}$	$29\frac{1}{3}$	29
0–5 - - both sexes	16·8	13·5	13·9
5–35 - - ,, -	4·0	3·0	2·2
35–55 - - ,, -	3·4	4·7	4·0
55 upwards - ,, -	8·4	8·2	9·0

The gross death-rate from all causes, at all ages, is found to have decreased in Dover, since the operations of the Local Board of Health, from $225\frac{1}{2}$ to 209 yearly per 10,000 inhabitants. Deduction of all cholera deaths brings the former figure to $221\frac{1}{2}$. The improvement has not

been to any perceptible degree due to a reduction of infantile mortality, as the death-rate of children under one year has only fallen from $47\frac{3}{4}$ to $46\frac{1}{2}$ per 10,000 residents in the mean of years after the public works.

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Smallpox and measles epidemics have been somewhat more fatal in the period since 1856 as compared with 11 years that were investigated prior to 1853. Scarlatina and whooping-cough on the other hand have been less fatal in the later period. In this also, diphtheria has made its appearance and (what might be anticipated from the free communication of the town with places in France, where diphtheria prevailed early and severely) has caused a relatively high number of deaths. "Fevers" have been reduced in their degree of fatality in the proportion of 14 to 9, the reduction affecting all ages and being observable from the earliest years of sanitary work. There is reason to suppose that all or nearly all of the fever is and has been typhoid. Only in one year of the last ten has the death-rate from fever reached the average that prevailed before the works were done. Diarrhœa has undergone some reduction, chiefly in children under five. Cholera, which in 1859 was fatal to 40 in the 10,000 of the then existing population, in 1854 (when the amendment of the town was in progress) was the cause of death to 10 in the 10,000. And in 1866 the mortality from the disease was still less, being only $4\frac{2}{3}$ for each 10,000 residents.

In Dover the mortality from consumption has been slightly reduced. Considering deaths from this cause only as affecting working ages, the rate of mortality has fallen from $21\frac{1}{3}$ to $17\frac{3}{4}$, men and women having profited to just the same extent. Lung diseases show a very small degree of increase, but this is solely (a circumstance elsewhere observed where a gross death-rate has fallen) among aged people. Brain diseases show an unimportant degree of reduction, chiefly at the ages of infancy; in adults there has been even a slight increase of their fatality.

WARWICK.—(Population of Borough, 1861, 10,570.)

WARWICK.

This town was inspected for the General Board of Health in December 1848, by Mr. Clark, from whose report the following particulars as to its then condition are taken:—

Previous sanitary condition.

"The town stands on the right bank of the Avon, from which nearly "the whole of it is divided by the castle and grounds of the Earl of "Warwick. On the left bank of the river is an inconsiderable suburb."

Site.

"The new red sandstone rock, on which the town is chiefly built, rises "here in a long ridge parallel to the river, towards which the surface "descends rapidly southwards. Northwards the descent is towards a "considerable valley which sweeps round the town." "Through this "valley two streams enter and discharge into the Avon, the north-"easterly one (St. Nicholas brook) being dammed up in its course to "supply a head of water for a water-wheel that pumps the water supply "of a part of the town, and again to make a head for a small corn mill." "The north-westerly stream receives sewage, and then spreads into a "large withy bed, and goes on as a foul ditch into the Avon, above "the point where the supply of water for the castle is drawn." "The

Natural drainage,

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" Avon itself is dammed up five or six feet by the weir above the castle, " but is free from any other obstruction for nearly three miles."

"The central, older, and better part of the town stands naturally high and dry. The houses upon the sides and near the base of the hill are mean, numerous, crowded, and damp. Others as bad, but less crowded, occur on the eastern side of the town, on either side of the Leamington Road. These are on low ground, and very unhealthy."

[The lower parts of the town towards the river are on gravel of very various depth, this gravel would probably be water-logged by the dams that hold up the St. Nicholas brook and the Avon.]

"No attention has been paid to the subsoil drainage of the town, nor, owing to the absorbent character of the soil, is the want of it felt."

" The natural drainage of the east side is somewhat impeded by the Castle mill on the Avon, and by St. Nicholas mill, for the benefit of which the waters of the Priory are dammed up. This millpool has been already referred to as a receptacle for sewage and a nuisance to the neighbourhood."

and sewerage.

" There are no sewers, properly so called, in Warwick. The surface " waters are received in the principal streets by 18-inch drains, none of " which are low enough to drain the cellars or intended to remove the " filth from the houses. These drains are fitted with enormous gutter " grates, which are much complained of for the foul effluvia they " give out. Besides surface water a good deal of offensive matter, over- " flow of cesspools, and the like, find its way into them." These sewers had five outfalls, more or less direct into the Avon, close to the town, and there formed beds of fœtid matter. One of the outfalls was into the St. Nicholas millpool, before noticed.

All the house drainage that existed has been mentioned. "Very " few houses in Warwick, and those only of the best class, are provided " with waterclosets. Usually there is in the yard of the house or in " a court common to many houses a large deep pit or cesspool sunk in " the sandstone rock, at one end of which is placed the privy, and into " which is thrown all the filth from each house, pigstye, stable, or " slaughter-house. The contents are usually piled and smell offensively, " especially when overflowing after rain : but the cesspools soak much " into the absorbent soil in which they are dug. Near the margin of the " town, the open ditches serve the purpose of these cesspools. A " return showed 1,516 cesspools connected with privies exposing some " 37,000 square feet of fœcal matter to sun, wind, and rain. The con- " tents of the cesspool are sold by the owner to the farmers."

Water supply.

" Warwick is supplied with water from three sources : spring water " from pumps and wells, brook water by the Priory machines, and rain- " water by tanks and cisterns." " The wells vary in depth from 40 to " 120 feet, being often 70 to 80, are expensive and yield very hard " water. There are 737 pumps connected with these wells in the " town. The water sometimes gets contaminated from the cesspools." " The water from the Priory brook is softer, but still of 20° to 23° of " hardness. It is impure, being stored in unkept pools which some- " times run dry in hot seasons. It is raised by a water machine " supplying the town with about 36,000 gallons daily, and is delivered " at a pressure sufficient to reach the ground floor of any house two " days in the week. About 80 houses were supplied, the houses storing " in cisterns what they can get." " Rainwater receptacles are tanks " in the ground, fitted with pumps. There are 327 of these, giving a " costly and precarious supply." " Water for the castle is taken from " the Avon."

"Warwick is but moderately paved. The footways are chiefly "flagged, but some are pitched with round pebble stones. The carriage "ways are formed in the same way or macadamized. The state of "certain roads and alleys is very bad, abounding in stagnant pools and "collections of nuisances." Many filthy conditions were found about the courts and poor houses in Mr. Clark's vists; courts "close, dirty, "undrained, and damp," with "cesspools and privies, and a main sewer "too high to take the drainage." "A place low and damp, with pools "of stagnant water, much complained of; near, at the back of a court, "was a pump deserted by the people because the water was poisoned "by the privy adjacent." "Pigsties are numerous, and the street dung "is collected and stored for sale in alleys, yards, and similar public "places," yet "the late operations of the corporation had removed many "nuisances."

Paving and cleansing.

"The main streets of Warwick are open to the wind, and a free ventilation is thus secured to the greater part of the town." But many courts were found ill-constructed and close, and many houses built back to back. No overcrowding is mentioned, except of common lodging houses. There were 12 of those houses in the worst quarters of the town; small, close, very dirty, and contain 132 beds meant to hold 264 persons, but at race and fair times actually accommodating a very much greater number, four or five to each bed, besides that other people were lodged on the floor.

Lodgment.

Sanitary works.

The works of sewerage and water supply in Warwick were carried out by Mr. Lister. They were begun in 1856 and the main sewers and waterworks were completed in 1858. At that time and since then to the present day works of private house drainage have been carried out.

Of sewerage.

The sewage was discharged by two outfalls into the Avon at some distance below the town and at points where the river is not held up. The western outfall should drain 1,254 houses, and does actually receive the drains of 1,223. The eastern outfall should drain 1,152 houses, and is actually connected with 620 or 650; the 500 houses that are not yet drained being mostly in the low-lying parts of St. Nicholas parish, and still being provided on the old system of cesspools and wells.

At the western outfall the sewage enters from the 18-inch pipe main into settling reservoirs and filters, where the whole or a part of it filters upwards through sand, and the remainder or the fluid portion flows on into Fisher's brook and thence a third of a mile into the Avon. The black sediment filtered out here sells for 5*s.* a ton. The sewage not being all always filtered makes the brook foul. The eastern outfall (which is at 9 feet lower level than the western) is also an 18-inch pipe, which (after a course in which its fall is only 1 in 1,800) enters into settling tanks in the meadows adjoining the Avon, the overflow going on into the river a mile below the town. The deposit beds retain the silt, but appear to let the soil go on pretty much unchanged. No means of deodorizing are used at either outfall. From the owners of property a mile lower down the river just above a milldam great complaints come of the sewage polluting the river.

The street sewers of Warwick, which are all pipes (the storm water going into a separate system), are from 18 down to 9 inches in diameter, and are laid in the loose sandstone rock or in the gravel at depths varying from 7 to 12 or 13 feet, deep enough to drain all cellars. The block plan of drainage is used for groups of cottages. All inlets of house drains are trapped, but some in streets are left open for ventilation. Rain spouts are sometimes used for ventilation, but as a rule roof water as well as other surface water gets into the old system of superficial sewers that has been made available for carrying off all but house and

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soil drainage. Flushing is provided at the top of each sewer by a two-inch pipe from the water main.

Every house that has been connected with the new system of sewers is provided with (separate or common) waterclosets that have water laid on from the main. The old middens have been filled up. It has been mentioned that 500 houses in a low-lying part of St. Nicholas still retain the old system of middens and wells.

Of water supply.

The water supply of Warwick was furnished at the same time as the drainage works were made. An attempt was made at considerable cost to get sufficient water by sinking a deep well, but this was unsuccessful, and no source could be got to yield sufficient quantity but the river. The water then was taken from the Avon $1\frac{1}{2}$ mile (as the river goes) above the town and above the branch river that drains Leamington. Fifteen miles above this intake the Avon has received the sewage of Coventry. The water gravitates from the river into filters of sand and gravel, and after passing through these it is pumped into a service tank, 60 feet high, situate in the town at nearly its highest part. It is delivered on the continuous system, only it is cut off from the higher parts during the night. The amount of water supplied per head per diem (reckoning only the houses that get the water and making no deduction on account of railway use, road-watering, and so on) is 30 gallons. Analysis of the water by Dr. Playfair in 1852 appeared to show an inefficient filtration ; with 18° of hardness and 28 grains of inorganic matter, there was also organic matter in considerable quantity and some brown particles of organic matter in suspension. Analysis by Mr. Spencer in 1865 showed 35·7 grains of total impurity with a larger quantity of chlorides than in the earlier analysis, and three grains of organic matter to the gallon.

Of paving, &c.

The streets were paved as the sewerage works were completed and the private courts were paved and drained.

Byelaws were adopted to regulate the construction of new streets and buildings ; for the drainage of old buildings and of the subsoil whenever the site appeared damp ; for the prevention of nuisances, and for improving slaughter-houses. And common lodging-houses were brought under inspection and regulation.

Present condition, 1865.

The present condition of Warwick is, with local exceptions only, very satisfactory. The sewers habitually act well and remove the soil of the town rapidly. No obstruction occurs except when pipes have been improperly laid, and the simple means used for cleansing them appear to suffice. The waterclosets are, in practice, adequately cleansed from the mains, and do not get materially out of repair. The surface of the town is kept dry and clean, though some few courts are still wet from imperfect paving. The effect of the new system of sewerage on the subsoil has been to remove much water from the gravel of the lower-lying parts. Wells have had to be sunk deeper ; graves in St. Nicholas churchyard are now dry instead of being filled with water as soon as dug, and cellars that were formerly wet are now dry. The higher parts of the town on the sandstone must have undergone less change in this respect.

The water supply is of sufficient amount, although there is great waste by ignorant propping up of the closet handles. Bad quality of the water is not complained of.

The town is kept clean and free from filth. Ashes and house refuse are removed from all houses once a week, often being kept in moveable boxes which are easily emptied. Only the small portion of the town that retains the cesspool system and still puts its ashes on the midden is left to get rid of filth by private management ; being well looked

after, ashes and soil are not here retained for any great length of time. Not many pigs are kept, but still some, even in central parts of the town, and a limited nuisance is of course caused by them. Only some Irish quarters are systematically dirty.

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The interior of houses is not inspected unless they are common lodging-houses. As a rule each family has its own cottage, and there are plenty of cottages to let. Rooms are seldom if ever let off as separate tenements, and the houses are not overcrowded. Common lodging-houses are well kept and not crowded. In all these houses the number of persons actually lodging averages 42, the highest mean number of any month having been 62, and this is not in excess of their proper capacity.

Mortality statistics.

The mortality statistics of Warwick have been investigated for the borough, which is the area of jurisdiction of the board of health. The deaths of persons not belonging to the borough, but dying in the union workhouse, have been omitted in taking the death rate of the town from all causes, and deaths occurring in the gaol have been omitted altogether. Of the statistical tables the following summary compares the mortality of Warwick before any sanitary works with the period after the public works of drainage and water supply, throughout which period however private works of house drainage have been going on :—

Per 10,000 of total Population.	Before (11 years, 1845–55).	During (3 years, 1856–8).	After (6 years, 1859–64).
		execution of chief Sanitary Works.	
Deaths from all causes, all ages, both sexes - -	227	194	210
All causes, children under 1 -	$51\frac{1}{4}$	$41\frac{1}{4}$	$46\frac{3}{4}$
Males - -	29·2	23·5	27·9
Females - -	22·0	17·7	18·9
Epidemic diseases :—			
Smallpox, all ages - -	$4\frac{1}{3}$	$0\frac{2}{3}$	$1\frac{1}{4}$
Under 5 - -	1·8	0·0	0·5
Over 5 - -	2·5	0·6	0·8
Measles, all ages - -	3	—	$4\frac{1}{2}$
Scarlatina " - -	6	$8\frac{3}{4}$	$4\frac{1}{2}$
Under 5 - -	3·0	4·4	2·0
Over 5 - -	3·0	4·4	2·5
Diphtheria all ages -	—	$0\frac{2}{3}$	$1\frac{3}{4}$
Whooping cough " -	$2\frac{1}{6}$	$4\frac{2}{3}$	4
Croup " -	$1\frac{3}{4}$	$1\frac{1}{4}$	$2\frac{2}{3}$
Erysipelas " -	$2\frac{1}{6}$	$0\frac{1}{3}$	$1\frac{1}{10}$
Rheumatic fever " -	$1\frac{2}{3}$	1	$1\frac{1}{10}$
Ague " -	—	—	$0\frac{1}{6}$
Fevers " -	19	$10\frac{4}{5}$	9
Under 5 - -	3·1	1·8	0·9
Over 5 - -	16·0	9·0	8·1
Diarrhœa, all ages - -	$5\frac{3}{4}$	$6\frac{1}{2}$	8
Under 5 - -	4·2	4·3	6·1
Over 5 - -	1·5	2·2	1·9
Cholera, all ages - -	(In 1849, 10)	(In 1854, 0)	(In 1866, 0)
Dysentery " - -	$0\frac{1}{6}$	$0\frac{2}{3}$	$0\frac{1}{3}$

Per 10,000 of total Population.	Before (11 years, 1845–55) execution of chief Sanitary Works.	During (3 years, 1856–8) execution of chief Sanitary Works.	After (6 years, 1859–64) execution of chief Sanitary Works.
Phthisis, all ages, both sexes -	40	33	$32\frac{1}{3}$
0–5, males -	3·4	0·6	2·5
„ females -	2·5	1·9	1·7
15–55, males -	16·0	11·5	12·7
„ females -	13·6	14·3	12·2
Lung diseases, all ages, both sexes.	$36\frac{1}{6}$	$27\frac{1}{3}$	28
0–5, males -	7·1	6·8	6·3
„ females -	7·6	6·2	4·9
15–55, males -	5·8	2·5	3·1
„ females -	3·1	1·2	2·5
Brain diseases, all ages, both sexes.	$31\frac{2}{5}$	31	$31\frac{3}{4}$
0–5, males -	7·5	7·1	6·7
„ females -	5·9	5·9	5·7
35–55, males -	1·7	2·2	1·9
„ females -	1·5	1·8	1·1

An improvement of moderate amount in mortality from all causes is observable. In only two years of the nine that have passed since the public works were begun has the mortality reached the mean of the period before any work was done. Infantile deaths (from all causes under one year) are slightly less numerous since the beginning of the public works. Of the more contagious diseases, smallpox and scarlatina have been notably less fatal; measles and whooping-cough somewhat more fatal. Fevers, the whole of which appear to have been typhoid, have been reduced to half their former fatality. Diarrhœa has risen in its mortality among children. A slight epidemic of cholera in 1849 has not since been repeated. Consumption, alike in children and adults, has distinctly declined, viz., from 40 to $32\frac{1}{3}$ annually in the 10,000 residents. Lung diseases, too, have declined in about an equal proportion. Brain diseases have been stationary.

BANBURY.—Population of Parliamentary Borough (1861) 10,238.

Previous sanitary condition.

Soil and site.

Mr. Rammell's report in 1850 contains the following statement relating to the condition of this town. "The town stands on ground of varied "geological character, which may be described generally as consisting of "inferior oolite [the part now called great oolite] with ferruginous "sands and beds of clay and brick earth." "It is situated on a slope "towards the north-east on the south-western side of the valley of the "Cherwell." "The fall of rain in 1848 was $35\frac{3}{4}$ inches; in 1849 it "was 28–30 inches." "The chief trade of the town depends on agri-"cultural produce. There are two ironfoundries, and a manufactory "for horse clothing and girths, and two others for plush."

Paving, &c.

"The paving of the borough has been satisfactorily attended to, but the streets of Neithrop (which forms part of the town but does not share the municipal government of Banbury proper) have inferior paving stones badly laid down. Banbury is very well scavenged, but Neithrop is utterly neglected in this respect."

Drainage.

"The municipal borough was partly supplied with drains before the "passing of the Local Act in 1825, and since that time some additional "drains have been laid down. No general system was adopted, and "owing to the bad arrangement of the public sewers in most instances, "the inhabitants of many parts of the town still have to complain of a "total want of facilities for house drainage." "The same neglect of "communication with the public sewers applies to the numerous pas-"sages and courts which adjoin the public streets." "The drains are "not all at a sufficient depth to drain the cellars of the houses. In "the principal streets of the town water is raised from the cellars into "the drain by buckets and creates a nuisance." In places "a strong "flow of water through the drain is apt to soak through it into the "house." In Neithrop there was but one inefficient sewer. Many streets in Neithrop were in a filthy condition, owing to neglect of drainage; "the excreta and house filth are thrown into the open street, "where they sometimes remain many hours, sometimes till the next "morning, before they are removed." In a Neithrop street "houses "are unable to have cellars because of the springs of water." The sewers discharged themselves into open ditches and thus into the Cherwell.

"The state of the privy accommodation is extremely bad throughout "the town, particularly those parts occupied by dense masses of the "poorer classes. In one thickly-populated quarter of Neithrop 115 "houses with 442 inmates had only 25 privies." "In another district "within the corporate borough 43 houses with 160 inmates have only "4 privies." Some houses having waterclosets discharged their soil into the sewers; but for the most part the liquid refuse only got into the sewers. The privies commonly had cesspools (not connected with the ashpit) which were emptied once a year or less frequently; or the soil was collected in boxes, emptied upon manure heaps, where it remained till the farmers fetched it.

Water supply.

The water supply was "mostly from wells yielding water of a very "hard quality. There are, however, a few wells (mostly private) of "tolerably soft water in parts of the town." The former were shallow wells, the latter sunk 40–70 feet deep through clay. The quantity supplied by the wells was defective, the public pumps being often out of repair, and some private wells being dry in hot weather.

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In Mr. Rammell's report no mention is made of the common lodging-houses or of the state of lodgment of the poor. It does not appear that there were many very confined courts, nor any notable overcrowding.

Lodgment.

Sanitary work.

Sanitary operations were begun in Banbury in July 1854. They were applied to the whole Parliamentary borough, and most of them were completed in July 1856.

Of sewerage.

The sewerage of the town was done on a uniform system. The greater part of the old drains were found useless, but a few were incorporated into the new plan. The new sewers are of pipe and brick, the mains being 4 feet barrels, the smaller mains 3½ and 3 feet barrels, and the street sewers under this size being pipes, lessening in size to 4 and 6-inch pipes, which drain houses and courts. Most sewers have a good fall, and are laid from 7 to 10 feet below the surface. The drains have been universally trapped at their inlets, excepting the rain spouts which, with some street openings, are left for ventilation. Private courts have all been drained, with a syphon or a brick trap at the inlet.

All cesspools were removed, with perhaps some very few exceptions, and the soil was passed into the drains. The watercloset system was adopted throughout the borough.

The sewers were made to have their outfall into settling tanks and filters from which the liquid part flows off into the Cherwell just below the town, and the solid part is mixed with town sweepings and ashes, and sold for manure. Additions have from time to time been made to these tanks, and there are now three series of them.

Of water supply.

Water supply was furnished by a private company which commenced its work at the same time that the drainage was improved. The water is derived from the Cherwell above the town, at a point a mile above the outlet sewer. After filtration it is delivered to the town on the continuous plan, being supplied all 24 hours round, at a pressure varying from 20 feet above the pavement at the highest parts of the town to 170 feet at the lowest parts. Provision was made for 18 gallons daily for each of a population one-third greater than existed.

Present state.

At present the town is well paved and cleanly, but some private streets and courts still want attention. The sewers and drains all act efficiently; the submains are frequently flushed by hose from 120 hydrants contracted for by the board. There is no place where the sewers get choked. At the outfall works, carbolic acid and perchloride of iron have been used to further purify the filtered sewage and to prevent complaints of the pollution of the Cherwell. Nevertheless nuisance from the river is complained of, and law proceedings have lately been taken in respect of it; any such nuisance is outside the town.

Some very interesting researches into the composition of the sewage and into the character of the river water before and after its entry were communicated by Mr. Beesley, who has made many analyses of them.

Effect of drainage on wells.

Many of the wells of the town have been dried by the sewers. The shallow wells of the town are, according to Mr. Beesley, sunk through a thin bed of alluvial gravel into the lias clay and get superficial water only: the deeper ones reached to fissures in the lias. It is only the shallow wells of 8–20 feet that have been affected by the drainage works. The sewage discharged into the river after 10 p.m. is little more than water from the springs. Some very flat parts of Neithrop where the soil is clay are still almost under water at times of flood.

Waterclosets though tolerably universal are not all directly supplied with water. About 100 are connected with the water mains, without

cisterns,* but much waste (it is estimated nearly half of the total supply) occurs on this plan. For a single $\frac{3}{4}$-inch pipe left open at the lowest part of the town, where the pressure is 160 or 170 feet, will permit the escape of about 21,000 gallons in the 24 hours. Outdoor closets are not connected with the water-mains, but are cleansed by a bucket of water being thrown down them. Practically this plan seemed to have answered, for no closet was observed to be choked even when misused by dirty people.

A majority of the houses in Banbury are supplied from the company's mains. Besides supplying the domestic wants of the town, about one-fifth of the total water supply is used in watering streets, and at the railway, and a brewery. Excluding such water, the mean supply per head per day for such houses as receive the water is about 28 gallons; more in summer than in winter.

The Cherwell at the point whence the water supply of the town is derived receives no sewage nearer than from Croperdy, a village $4\frac{1}{2}$ miles up the river.

Cleansing, &c.

The board undertakes the regular removal of dust and house refuse. Small heaps were seen about some courts where no dustbin was provided, and these should be removed once a week by the scavengers. As these heaps were mainly of dry ashes they were more offensive to the eye than to the nose. In the corporate parts of the town, the ashes are collected into moveable boxes, emptied about twice a week. Pigs are not unfrequently a nuisance, and for the last two years more of them have been kept in the little gardens of the poor in Neithrop.

Although there is not much inspection of the interior of houses, there is no doubt that domestic cleanliness has much improved. There are not many instances (and perhaps none) of two families in one house, so no overcrowding exists unless it may be of too large a family into too small a house. Four common lodging-houses are well inspected, and are scarcely ever filled up to their licensed numbers.

Statistics of mortality.

For the purpose of statistical inquiry into the mortality of Banbury, the whole of the Parliamentary borough has been taken. Correction has been made for the inhabitants of other parts of the union dying in the workhouse, a very careful return from the master of the house having enabled each death to be classed as it occurred in inmates, or in people resident in the borough, or resident in other parts. The following is a summary of the statistics :—

Per 10,000 of Population at all Ages.	Before (9 years) 1845–53.)	During (3 years) 1854–6.)	After (8 years) 1857–64.)
	execution of Drainage and Sewerage Works.		
All causes, all ages, both sexes	234	217	205
All causes, under 1 year -	53	$55\frac{1}{2}$	45
Males - -	31·1	32·4	24·1
Females - -	21·9	23·1	20·9

* In future the water company intends to insist on every closet having a small service cistern with two valves so arranged that the entrance of water from the main into the cistern is stopped by the same action that lets the water from the cistern to flush the closet.

Per 10,000 of Population at all Ages.	Before (9 years, 1845–53.) execution of Drainage and Sewerage Works.	During (3 years, 1854–6.) execution of Drainage and Sewerage Works.	After (8 years, 1857–64.) execution of Drainage and Sewerage Works.
Epidemic diseases :—			
Smallpox, all ages - -	$5\frac{3}{4}$	$0\frac{1}{3}$	$1\frac{1}{2}$
Measles, all ages - -	$2\frac{1}{3}$	—	$5\frac{3}{4}$
Scarlatina, „ - -	$7\frac{3}{4}$	$3\frac{1}{4}$	5
Under 5 - -	5·1	2·5	3·5
Over 5 - -	2·7	0·7	1·4
Diphtheria all ages -	—	$0\frac{1}{3}$	$1\frac{3}{4}$
Whooping-cough „ -	$3\frac{1}{6}$	$4\frac{1}{3}$	$3\frac{1}{2}$
Croup „ -	$1\frac{1}{6}$	$2\frac{3}{4}$	3
Erysipelas „ -	$0\frac{3}{4}$	1	$1\frac{1}{3}$
Rheumatic fever „ -	$0\frac{1}{2}$	$0\frac{1}{3}$	$0\frac{2}{3}$
Ague „ -	—	—	—
Fevers* „ -	$19\frac{1}{2}$	$13\frac{1}{4}$	9
Under 5 - -	3·0	3·6	2·7
Over 5 - -	16·4	9·7	6·3
Diarrhœa, all ages - -	$11\frac{1}{3}$	11	$5\frac{1}{2}$
Under 5 - -	7·2 (2·1 w.ho.)	6·4 (3·9 w.ho.)	3·3 (1·2 w.ho.)
Over 5 - -	4·1	4·8	2·2
Cholera, all ages - -	$0\frac{1}{2}$	$3\frac{2}{5}$	—
Dysentery, „ - -	$0\frac{1}{8}$	—	$0\frac{1}{2}$
Phthisis, all ages, both sexes -	$26\frac{2}{3}$	$16\frac{4}{5}$	$15\frac{3}{5}$
0–5, both sexes -	1·3	0·7	0·7
15–55, males - -	9·1	6·1	5·6
„ females -	12·6	8·6	8·0
Lung diseases, all ages, both sexes.	$29\frac{1}{4}$	$31\frac{1}{3}$	$29\frac{4}{5}$
0–5, males - -	7·5	7·1	8·1
females -	6·3	6·4	6·5
15–55, males - -	2·5	3·9	3·0
females -	2·1	3·2	1·4
Brain diseases, all ages, both sexes.	$27\frac{1}{2}$	$23\frac{1}{2}$	$25\frac{1}{4}$
0–5, males - -	9·3	5·7	7·2
females -	5·0	6·1	6·3
35–55, males - -	1·7	2·1	1·2
females -	0·9	1·1	2·0

* Or excluding all fever deaths in workhouse *inmates*, the total death-rates for fever at the three periods become 16, $12\frac{3}{4}$, $8\frac{1}{3}$.

A notable decrease in total mortality will be observed. Probably, if a separate examination had been made of the registers for Neithrop and other townships as against Banbury proper, the decrease of mortality would have been found to be more remarkable in the former, inasmuch as Banbury township never had a very high mortality. That is the opinion of local medical practitioners. Certainly, the improvement that has been effected in the whole borough in cleanliness, drainage, and water supply must have been most wanted in Neithrop. The decrease in

aggregate death rate has been pretty constant from year to year. The highest mortality before the sanitary works was 31·0 and the lowest 18·6 in the 10,000. Since the works, the highest mortality has been 25·5 and the lowest 14·9 in the same number of residents. In the general reduction, children under one year of age have, though not specially, participated.

The more contagious class of epidemics do not show a universal diminution of mortality. Measles more than doubled its fatality in the latest period as compared with the time before sanitary works. Scarlatina, on the other hand, has in recent years caused only two-thirds of the death rate of earlier years. Whooping-cough has been no less fatal than formerly. Fevers of continued type, the great bulk of which are certainly typhoid, show a reduction to one half of their former mortality. Diarrhœa has been reduced to less than half its former mortality.*

A little cholera in 1854, scarcely any before and none whatever since, will be observed. Phthisis has diminished to a very remarkable extent; it was never a very fatal disease in Banbury, but it has been reduced to less than three-fifths of its previous fatality. Lung diseases have been stationary; brain diseases almost so.

PENZANCE.—Population (1861), 9,414.

PENZANCE.

The following account of the condition of this town, before the application of the Public Health Act to it, is extracted from the report of Mr. G. T. Clark, who examined it for the General Board.

Condition before sanitary works.

Site and soil.

" A municipal borough, including in its limits a circle of half a mile radius, nearly one half of which is sea. It lies on the sheltered side of Mount's Bay, and has with its suburbs a frontage of about a mile and a quarter on the sea, of which part is cliff, part is esplanade. The western margin is low and swampy; elsewhere the land rises rapidly, so that the town is built on the slope of a hill, which reaches an elevation of 220 feet behind it. The town rests on greenstone, and is encompassed landward by granite. A considerable part of the town, however, rests immediately on a sort of red marl, seen in the eastern cliff. The climate is mild, but moist, with an average annual rainfall of 45 inches. The prevailing wind is south-west.

Construction of town and house arrangements.

" The construction of the town is faulty, having many courts and alleys, which by a little management might be opened to the sea-breeze." The following places are described: A street standing high, but undrained, from which runs a number of courts with small houses in them. In many cases the ground rises behind the houses and drains upon them. The courts are made close, badly paved, without drains, but with an

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* Inasmuch as many deaths from this disease have been registered among inmates of the workhouse, (this institution, though in the borough, is beyond the drainage system, and until recent years was managed in defiance of some obvious sanitary considerations,) deduction may be made for them in each of the three periods adopted in the above table, and then the diarrhœa deaths in the Parliamentary borough will be—before works of drainage and water supply, $9\frac{1}{4}$; during the drainage, &c., works, 7; after those works, $4\frac{1}{4}$ per 10,000; the reduction of diarrhœa mortality in the town still being to the extent of one-half.

open irregular gutter receiving the overflow of cesspools and privies, and forming a number of stagnant, offensive little pools close to each door and window. In the yard of each tenement is a privy, usually filthy and out of repair, and having an open cesspool on one side of it, into which a variety of filth and refuse is thrown. The cesspool, flooded by a shower, runs over into the gutter before described. In another locality, owing to the want of space, 'Many tenements have privies and 'often cesspools under the roof of the dwelling-house; in other cases 'the filth from an upper story is discharged by an open shoot into the 'court or passage below; while other houses are absolutely without a 'convenience of any kind, and use the street or throw filth over the 'harbour wall. It is a locality made by nature to be healthy, but from 'its foulness epidemics and diseases of the bowels are never absent.' These instances are multiplied. The cesspools were emptied by private arrangement once or twice a year.

Sewerage.

"With one trifling exception, it does not appear that there is any sewer in the town calculated to drain an underground kitchen or cellar. In some of the streets there are covered drains with grates for the surface water discharging into gutters of lower level or into open ditches alongside the public walks. Owing to the natural fall there is no difficulty in getting rid of the surface water. There is no house drainage.

Water supply.

"The town is dependent for its water supply on about 53 private wells and pumps and six public pumps, four of which were found dry; the wells were all sunk down to a considerable depth. There are also six public spouts fed from a reservoir, which gets its water from certain streams outside the town, and three other spouts fed by springs. The supply is never very copious, and quite inadequate in summer, when its want is severely felt, especially by the poorer classes.

Paving and cleansing.

"The main streets of the town are either paved or macadamized. In the smaller streets the paving is very deficient indeed, and some narrow lanes are in wet seasons impassable. Scavenging is only done as regards refuse cast into highways, and takes no cognizance of alleys, house dust, or refuse; though, indeed, when house filth is emptied at once upon the high road it is removed by the scavengers. The town is lighted with gas.

"Besides the numerous exposed dung-heaps and cesspools, nuisances were caused by depots for scavengers, dirt, and by some ill-regulated trades. There were eight unregulated common lodging-houses."

Nature and effect of sanitary work.

The works that have been done for the sanitary improvement of Penzance began, in 1850, with the supply of water, which was complete in 1855. Then in 1854 works of sewerage were commenced, the main part of which was finished by 1856; but the connexion of private houses and new streets with the system has been going on up to 1864, and since the last-named year works of street improvement have been extensively carried out.

Water supply.

The waterworks consist of a storage reservoir with service reservoirs, $1\frac{1}{3}$ mile off town, and of a service main (recently constructed in duplicate), which delivers the water by gravitation to the town. The supply is on the constant system, all twenty-four hours round; and its pressure is 220 feet at lowest parts and 70-80 feet at highest parts of town, so that water can be delivered everywhere to the tops of houses. The storage amounts to 37 days' supply, and the amount has never run short, though in time of drought the service has been stopped between 12 and 4 a.m. The water is unfiltered, but makes no noticeable amount of deposit. The supply of water to houses is either in or outside the house; waterclosets are supplied direct from the main with a self-acting valve on the pipe. In the absence of wanton misuse there is no great waste in this contrivance. The water has not been supplied inside the

poorer sort of houses until recent years, when waterclosets had been substituted for cesspools. In the first years of water supply to the better sort of houses many cesspools had overflowed and flooded basements; so it was found desirable not to supply water everywhere till drainage was complete.

Sewerage.

The sewers of Penzance are devised on the pipe system, storm water and most ordinary surface water going along channels in the streets to the sea. Courts and yards, some roofs, sinks, and water closets drain into the pipe sewers. These are impervious, and range in size from 15 inches in the main sewer, to 4 inches for the connection with houses. They are laid deep enough to drain every cellar, lying at an average depth of 9 feet. The incline of the street pipes is regulated by that of the surface, and varies from 1 in 120 to 1 in 15. This system has two brick outfalls into the sea, one below low water mark, while the other is uncovered for 3 to 4 hours of the tide. Into these outfalls storm water is also received. The sewers are ventilated near the outfall by a special pipe, to prevent back pressure of air by the tides, and elsewhere by iron pipes carried to the chimney tops of the highest houses at the highest parts of the town. Rain spouts so far as connected with the pipe sewers, are trapped. The sewers are very rarely flushed, but have not been found to choke or silt up; the water mains can be connected with the sewers when it is desired to wash the latter out.

House drainage.

Houses are drained into the sewers on the block plan, and this appears to work satisfactorily. The inlets to all drains on the ground level are trapped; those in yards by a very good form of iron trap contrived not to be choked by careless use, and those of water closets by the ordinary earthenware trap, specially made with its narrowest part against the pan of the closet, so as to give advantage of flushing and to keep improper substances out. Almost all the closets and sinks within the borough were connected by the Local Board itself, being done both cheaper and better than elsewise. Such works have only lately been completed throughout the town.

Difficulties have been met with in finding proper situations in some houses for the necessary conveniences that the Local Board required, but all such difficulty was got over by the plan adopted by the Board of doing everything by their own servants. When there was no back opening to a house, a closet has been contrived at the top of the house, and a room has been set apart for the dust-barrel and the water-sink. And by a little such management in each case, all difficulties appear to have been met, and there is now not a house in the town (barring those in courts where there are common necessaries) that has not its own privy and water supply. It is curious to see to what an extent the people have learnt the use of the conveniences supplied to them, and how great an improvement in their manners has followed. The thorough practical knowledge that was brought to bear by the servants of the Local Board seems to have procured well-adapted work that does not get out of order, whereas if the cheapest possible makeshifts had been put up by small tradesmen they would speedily have got dilapidated, and in all ways there would have been more opportunity for their misuse. After the statement that closets were constructed within certain of the poorer sort of houses, it is right to add that, in an inspection of a good many of those, there was not a particle of drain or privy smell anywhere observable.

The effect of the construction of sewers upon the subsoil of the town has been inconsiderable, if any. Only portions of the town stood on porous soil, and its wetness (never great) cannot have been appreciably altered. No wells were affected at all by the drainage works.

Paving and cleansing.

As the sewerage works progressed into private streets and courts and the back yards of houses, such areas were at once paved by the Local

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Board, the greater part of such paving being the work of the last few years. Every house or court is provided with a moveable dust receptacle, commonly a barrel, the contents of which are removed on alternate days by the contractors of the board; the man being bound to call at every house, not only to take away matters put into the street for him. The only fixed dust bins in the town are a few upon which stable dung is required to be thrown, and these appear to be well cleaned out. Scavenging is done by the Board, and some room for improvement confessedly exists in this respect.

As regards the lodgment of people, the common lodging-houses have been regulated, and are carefully inspected by the police; overcrowding has been looked after in the rare cases where it exists, and on one occasion a summons was taken out.

Statistical inquiry.

The mortality statistics of the town of Penzance have been investigated from 1843 to 1865, the area of the borough alone having been taken for inquiry; and correction has been made for the deaths of townspeople in the outlying workhouse. It will be kept in mind that a change in the source of water supply, a more copious delivery of it, an improvement in cleanliness, and inspection of the town are the only works that can yet have borne fruit.

Per 10,000 of total Population yearly.	Before any Work (8 years, 1843–50.)	During Main Works (5 years, 1851–5.)	During House Works (10 years, 1856–65.)
Deaths from all causes, all ages - - - -	221	245	222
All causes, under 1 year -	50½	59⅓	51
Males -	28·1	31·4	27·4
Females -	22·4	28·0	23·6
Epidemic diseases:—			
Smallpox - - all ages	0⅔	18⅓	0⅔
Measles - - " -	8⅔	4⅓	3⅓
Scarlatina - - " -	5	10	6
Diphtheria - " -	—	—	1
Whooping-cough " -	7	4	8⅓
Croup - - " -	2¼	5⅓	2⅓
Erysipelas - - " -	1¼	0¾	0⅔
Rheumatic fever " -	0⅓	1⅓	0½
Ague - - " -	—	—	—
Continued fevers, probably no typhus. " -	7½	7½	8
under 5	1·5	2·1	1·3
over 5	6·0	5·4	6·7
Diarrhœa, all ages - -	5⅓	4⅓	9⅓
under 5	4·3	3·2	7·7
over 5	1·0	1·1	1·6
Cholera - - all ages	(In 1849, 1 case.)	(In 1854, no case.)	(In 1866, no case.)
Dysentery - - " -	13⅓ (Irish epidemic most in 1848.)	2⅓	0⅔

Per 10,000 of total Population yearly.	Before any Work (8 years, 1843–50.)	During Main Works (5 years, 1851–5.)	During House Works (10 years, 1856–65.)
Phthisis, all ages and both sexes.	$30\frac{2}{3}$	$31\frac{1}{2}$	29
15–55 Males	11·2	10·8	12·6
15–55 Females	12·0	15·8	11·9
Lung diseases, all ages and both sexes.	$17\frac{2}{3}$	$21\frac{1}{4}$	$26\frac{1}{3}$
0–5, both sexes -	8·4	9·3	10·1
15–55 males -	1·7	1·9	1·7
15–55 females -	1·2	1·3	2·0
55 upwards, both sexes	5·9	8·5	12·2
Brain diseases, all ages and both sexes.	25	$29\frac{3}{4}$	$31\frac{3}{4}$
0–5 - both sexes	11·1	12·3	11·4
5–35 - ,, -	4·7	3·9	2·7
35–55 - ,, -	1·8	2·8	3·7
55 upwards ,, -	7·3	10·8	14·0

The deaths from all causes have been at the same average rate in the earlier and later years of the period under review, viz. at 221 per 10,000; and infantile mortality has been also stationary. Of the more contagious febrile diseases, smallpox was violently epidemic during the earlier period of sanitary work, but no serious amount of it has occurred either before or after 1851–2. Measles, occurring in epidemics strongly divided from each other, has been less fatal in its later attacks. Of whooping cough, however, there has been decidedly more, and particularly the epidemics have not been so much marked off from each other. Of scarlatina there have been only three epidemics in the 22 years, and the last, in 1863–4, has been decidedly the most fatal and of longest duration. Diphtheria, newly appearing since 1858 on the register, has caused a few deaths. Croup was more seriously prevalent for a few years about 1853 than before or even than in later years. Probably all the fevers of Penzance have been typhoid. They have remained almost exactly stationary in amount. Diarrhœa has even increased in fatality, both in children and in old people; but there has been no repetition of the epidemic of Irish dysentery that was so fatal in 1848.

Deaths from consumption have remained just where they were; at working ages among males having even increased to a trivial extent. Lung diseases too, in persons of all ages, have become a little more fatal. In respect of these two kinds of disease it is possible (though not insisted on as a fact by the best local opinion) that some increased use of Penzance may be latterly made as a place of resort for invalids. Brain diseases, in persons beyond the age of infancy, have been registered more frequently as a cause of death in recent years.

The whole influence of changed and more abundant water supply therefore (with such sanitary inspection as has been given), has hitherto had no perceptible effects on the death register. But as there is no evidence that the previous water was bad, though it was doubtless scanty, and as no time has elapsed since the full operation of the watercloset system (with other important measures adopted at the same time), there is no room for surprise that deaths and disease remain much what they formerly were.

Previous sanitary state.

Soil, &c.

City of Salisbury.—Population (1861) 9,030.

In 1851, the state of the city was described by Mr. Rammell in the following extracts :—" Whilst the principal streets are in themselves " wide and airy, there are, for the most part masked from outer view, " whole honeycombs of narrow courts utterly undrained, in a filthy " state, and crowded with inhabitants." " Numerous streams of water, " supplied from the Avon, run through most of the streets." " The soil " is a very porous gravel, containing everywhere a good deal of water, " which rises to within a short distance of the surface. There have " been several instances of the cathedral being flooded by the water of " the subsoil. The foundations of the houses are, almost without ex- " ception, damp." " From an unreclaimed swamp at the north of the " town an effluvium arises, which, under certain states of the weather, " is greatly complained of." " A falling off in population between " 1831–41, and between 1841–51 is in part to be accounted for by the " bad reputation of the town in regard of cleanliness and healthfulness." " Striking evidence was adduced as to depreciation in the value of house " property."

Drainage.

" The drainage system of the principal part of the town is formed by " the open channels which run along by the footpath at one side of the " street, and the house drains, which are square drains measuring " generally about four inches square, empty into them from both sides. " The fall of these drains is necessarily very small, they are frequently " in their whole length below the level of the water in the open channel, " and consequently, so far from being able to eject their contents into " the common stream, they are in such cases generally filled with " water from the channel. In order to counteract the evil consequences " resulting from this circumstance it is the practice for a certain time " every day to shut off, wholly or in part, the supply of water into the " channels, which gives the house drains the opportunity of partially " cleansing themselves. In this process, the more active of the house " drains send forth streams of refuse of every sort, including the privy " soil, while the more sluggish ones are loaded at the orifice with such " matters which remain there until the water being let again into the " channels washes them either down the common stream or up again " into the particular drain from which they emanate. The smells " arising from the channels, during the periods when they are clear of " all liquids except that of the refuse of houses, is highly offensive." " The highest portions of the town above the level of the Avon were, " until May last, wholly unprovided with means of drainage." " The " new drains are ill-constructed, and nuisances resulting from them are " complained of."

" There is a great deficiency of privy accommodation, and where privies exist they are for the most part in connexion with cesspits, which being, generally speaking, very rarely emptied, get rid of the liquid portion of their contents by flooding into overflow drains, or by leakage into the soil."

Water supply.

" The inhabitants are supplied with water but very imperfectly from " pumps connected with wells dug in the substratum. These wells are " generally dug about 8 or 10 feet deep, the water rising to within " 2 or 3 feet of the surface. The water is frequently injured by the

"leakage from cesspools, and from accumulation of nuisances on the "surface of the ground." "In the cottage property, one well serves for a "considerable number, the inhabitants often resorting to the neigh- "bouring drainage channels for the water used in washing their clothes and premises."

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"The principal streets are very fairly paved." "Most of the courts "are unpaved, or badly paved with rough stones; and with respect to "scavenging, there does not appear to be any organized system for "that purpose. No doubt the sweepings are often thrown into the "open channel."

Paving. Nuisances.

"In addition to the nuisances unavoidably arising from want of drainage, there are others of various kinds abounding in all parts of the town, as dungheaps, piggeries, slaughter-houses, &c., the liquid refuse from which stagnates upon the surface or runs into the nearest open channel."

In his tour of inspection, Mr. Rammell notes "overflowing privies," "neglect and filth," "water got on sufferance from the neighbours," "stench horrible," "pavement wretchedly decayed," "wells polluted by leakage," "water deeply discoloured and smelling offensively," and other such conditions in abundance.

"There is a great deal of vagrancy in Salisbury, and five common lodging-houses for tramps, complained of as a fearful nuisance both by night and by day."

"The general sanitary condition of Salisbury is bad, and has been "so at all times." "In 1849, one-fortieth of the inhabitants were "killed by cholera."

Sanitary operations. Of sewerage.

The sanitary works of Salisbury were begun in 1853. "For drainage "and sewerage the works consist (Mr. Middleton writes in 1864,) partly "of brick mains and partly of circular glazed earthenware pipes." The outfall is into the Avon by a brick main 4 feet 6 inches in height and 3 feet wide (with an open mouth), the bottom of which is one foot above the lowest summer level of the river and one foot below the ordinary level. This sewer is continued into the town with a gradient of five feet to a mile, and at its entrance to the town is nine feet below the roadway. From the main, two branch sewers of somewhat smaller size are continued, with a gradient of 8 feet 3 inches to a mile. Into these mains, circular earthenware pipes, of sizes varying from 15 to 9 inches diameter, convey the sewage from the various streets. These pipes are laid at a ruling gradient of 22 feet in the mile, and carefully cemented, and at their sides are draintiles arranged to carry off the subsoil water. In the main sewer a rapid run of water from the subsoil always exists. [The brick sewers have a floor of hollow stoneware pieces laid without cement, and these receive subsoil water.] "As the house "drains were found badly made with bricks uncemented and at wrong "levels they were condemned, and earthenware pipes of six inches and "four inches diameter substituted at proper inclinations. At various parts "flushing wells are placed at the corners of the streets, by means of "which the pipes are flushed from the hydrants when needed. Ventila- "tion is secured by many of the rain-water pipes being connected with "the house drains."

Of water supply.

"The waterworks consist of an engine-house, with a pair of double cylinder engines of about 25 horse-power, which are connected to the pumps in a well within the same building. The well is 68 feet deep; at its bottom is a tunnel excavated in the chalk, 70 feet long, which serves to increase the gathering surface of the well. The water is raised from the well to a covered brick reservoir, on a height of 146 feet. This reservoir will hold 260,000 gallons [now 300,000], and is placed high enough

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for all the houses of the city to be supplied from it. The water is distributed to the houses in iron pipes, at high pressure ; the supply is constant during greater part of the 24 hours (6 a.m. to 10 p.m.) The quantity raised is upwards of 500,000 gallons daily, or more than 40 gallons as the average daily supply for each inhabitant of the borough. The quality of the water is excellent, not half so hard as the average of wells, and softer than that of the river Avon. There is no organic matter in it."

"The cost of these sanitary works for the whole borough was, of drainage, about 13,000*l.*, of waterworks 14,000*l.*, total 27,000*l.* The works were planned by Mr. Rammell."

[The public works were completed in 1855 ; by 1856 about half the houses were connected with the new system of drainage and water supply, but all are not now universally so connected—1865.]

"When the canals were destroyed and the roads reconstructed, most of the footways were paved with Caithness stone."

Present state.

On the occasion of inspection for this report, the present condition of Salisbury was found wonderfully different from its state 15 years ago.

As to subsoil.

The subsoil is now dry, and cellars of considerable depth can be made even at the lower parts of the town, and these do not become flooded at any time. On an average the subsoil water has been lowered four or five feet over the city. The cathedral has never been flooded since the drainage works.

As to sewage,

The sewage is not employed for irrigation, but some of the water drained from the city area is conveyed, in pursuance of ancient rights, to irrigate meadows near the town. The sewage enters a branch of the river Avon at a short distance from the city, in a place where there is a fair current even in dryish weather. There are no settling tanks or arrangements for straining the sewage, which enters the river very little changed, and stools and paper can be recognized issuing from the outlet. This branch of the river has to be frequently cleaned out, or it would get choked by the sewage and rank weeds. In a visit on a hot day, when the river was somewhat low, there was no offensive smell. Not far from the mouth of the sewer large trout have been lately caught.

and sewers.

The inlets to sewers outside the houses are all trapped by bell, syphon, or gully, according to their size. Within houses the inlets were all trapped at first, and though the traps have since been frequently damaged, they are set right as soon as found amiss, and practically there are few untrapped inlets.

The sewers, after ten years' experience, are found to act well, and to have no deposit beyond what is easily got rid of by flushing regularly once a fortnight, with extra attention to some sewers that are nearly on a level.

As to water supply.

The water, being supplied on the continuous system under high pressure, no cisterns are provided to houses. Occasionally, the higher parts of the town, where the pressure is of course least, get short of water while it is being wastefully used by people living at a lower level. Weather makes no difference in the amount of supply. The demand for water increases immensely from year to year. From the 40 gallons per head per day obtained by dividing the total supply of water by the population of the borough, a deduction must be made for water taken by two railway companies, amounting to 8,000,000 gallons a year ; for manufacturing consumers, as maltsters and brewers ; and for street watering. But a further very serious deduction has to be made for this waste of water incident to the system of continuous supply. In better class houses, water-taps are placed inside, but for poor tenements there

is a common supply, without any self-closing apparatus connected with it, outside the house and common to several houses. An attempt was made to use a "waterwaste preventer," but it was found to freeze up in the winter, and had to be disused. There is no house without a supply of water, either to itself, or easily accessible.

A good many private wells still exist in the city, but there are no public wells now.

The use of the watercloset is now almost universal in Salisbury. There are very few of the old privies remaining, and they are mostly over the river brink, or in the outskirts. The ordinary closet for the poor districts has an earthenware pan with syphon pipe, and water direct from the main laid on with a self-closing valve. The tap is often fixed open, however, out of ignorance or mischief.

As to cleansing.

Ashes and house refuse are mostly collected into moveable boxes, which are emptied twice a week by the "town's cart," but there are a good many large fixed ashpits, which are only emptied at long intervals as they get full, and then either by the officers of the board, or by the owner.

The streets are now well paved and clean. The courts too are generally fairly paved with brick or flint.

As to nuisance removal.

Besides a special sanitary inspector, the sergeants of police are employed as inspectors to execute the Nuisances Removal Act. They have rarely interfered with the interior of houses, but have occasionally reported some to be dirty. No overcrowding of houses is known of, nor have any proceedings against this nuisance been taken. Common lodging-houses are looked after by these inspectors under the Act of 1851. Private slaughter-houses are not in all cases satisfactorily kept, and nuisances occasionally arise from them; but they have been much better looked after of late years. A code of byelaws has been adopted regulating the duties of officers, the removal of refuse and manure, the cleansing of waterclosets and emptying of privies, the construction and sewering of new streets, the drainage and other circumstances of buildings, the arrangements of slaughter-houses, and other matters bearing on public health.

The population of Salisbury, which had been gradually diminishing from 1831 to 1851, had risen slightly again at the census of 1861; it is said that there are fewer empty houses now than at that time, and that the city has quite lost its bad repute of unhealthiness.

Mortality statistics.

For the purposes of statistical inquiry, the city of Salisbury proper has been taken, parts of the borough lying outside the city having been excluded. The population of the city year by year has been estimated upon the basis of three censuses, with careful allowance for fluctuations ascertained by local inquiry. An abstract of the death registers of Salisbury had already been made by Mr. Middleton, and from his manuscripts the accompanying statistics have been chiefly compiled. It may be well to say that Mr. Middleton is not answerable for more than the correctness of the abstract, the analysis of it and the subsequent computations having been done independently of him. Of the statistics of Salisbury for the past years the following is a summary, showing the variation in total mortality, and in the prevalence of the more important causes of death before, during, and after the execution of the sanitary works:—

Per 10,000 of total Population yearly.	Before (as under) execution of Sanitary Works.	During (4 years 1853–6.) execution of Sanitary Works.	After (8 years 1857–64.) execution of Sanitary Works.
	(1844-52 9 yrs.)		
Deaths from all causes at all ages - - - -	275	249	219
Ditto, excluding cholera deaths	240	245	219
	(1844–50 7 yrs.)		
All causes, under 1 year -	43	?	40
Epidemic diseases :—	(1842-52 11 ys.)		
Smallpox (all ages) -	8	7½	1⅓
Measles „ - -	6¼	6⅓	5½
Scarlatina „ - -	2¼	12⅓	9
Diphtheria „ - -	—	—	0¾
Whooping-cough „ - -	4¼	0⅓	3
Croup „ - -	0¾	2	1
Erysipelas „ - -	1½	1⅓	0¾
Continued fevers „ - -	7½	5⅓	1¾
Diarrhœa „ - -	6⅓	5⅓	2⅔
„ excluding 1849, when epidemic with cholera.	4		
Cholera (all ages) - -	(in 1849, 180)	(in 1854, 14⅔)	(1866, perhaps 1)
Dysentery „ - -	0½	0½	0⅓
Phthisis, all ages and sexes -	44⅓		22⅔
Under 5 - -	5·1	?	1·1
5–20 - -	4·1		1·9
20 upwards -	35·1		19·6
Lung diseases, all ages and sexes.	33⅔		34⅔
Under 5 - -	13·5	?	14·9
5–20 - -	1·8		0·9
20 upwards -	18·4		18·8

Upon this tabular statement, the chief points to be noted are (*a*) considerable reduction of the aggregate mortality even with allowance for deaths in the cholera epidemic of 1849, (*b*) increase in scarlatina, (*c*) great decrease in continued fevers, (*d*) decrease in diarrhœa, (*e*) comparative absence of cholera in 1854, (*f*) great reduction in fatality of consumption.

On these points it is further to be observed that there has been considerable regularity from year to year in the subsidence of the total mortality: that the mortality from scarlatina in the third period has been spread over seven consecutive years, during which there have been three epidemic exacerbations; that the decrease in continued fevers (which may be regarded as exclusively typhoid) is not only of great amount, but is regular and undisturbed; that the diarrhœa deaths have fallen off from their number of the first period mainly

because of the epidemic prevalence of the disease in that period along with cholera, but also that the reduction is due to a smaller prevalence of the disease in its habitual form; and, lastly, with regard to consumption, that the diminution is found to be constant and pretty regular each year when the third period is compared with the first; that the reduction is to be seen in the mortality of all ages, and that it appears to be real and constant for a considerable number of years.

No other cause of any consequence can be suggested for the improvement in the public health of Salisbury than the sanitary measures which have been carried out in the city.

CHELMSFORD.—Population (1861) 8,664.

The following account of the state of this town in 1849, before it was put under the operation of the Public Health Act, is abridged from the report of Mr. Cresy, inspector of the General Board of Health.

Previous sanitary condition.

The town lies at the confluence of the rivers Chelmar and Cann. The river below the town has been navigable, with the assistance of locks, since the beginning of the century. The town, lying on a gentle incline, is on the London clay, with 15 or 30 feet of gravel above it. On the south of the river lies Moulsham, a hamlet of Chelmsford, which itself is on the north and between the two rivers. A long main street crossing the river and passing through Chelmsford and Moulsham, with several subordinate streets and some courts, represents the general plan of the town. Nine or ten years ago (*i.e.* about 1840) a freehold estate of considerable extent was divided and sold in small lots for building, and some hundreds of houses, consisting of four rooms, were erected, apparently beyond the requirements of the town, as at the time of inspection 200 were found empty. "Modern buildings are of brick, but in the more ancient houses a great deal of timber construction is seen. In the absence of control each builder has adopted his own mode of drainage; the privies attached to the cottages of the labouring classes, with their attendant cesspools, are situated just under the back windows." The removal of rainfall was effected in the main by mere surface drainage into the river. Such sewers as existed received some little nightsoil as well as surface water; some of them appear to have been noteworthy chiefly through their faculty of overflowing cellars. In the report an account of constant cesspools, privy nuisances, foul ditches, and cellars from whence water had to be pumped out, is given. "The privies and cesspools are generally in bad condition. Surface drains are not unfrequently used to carry away the sullage from the overflowing cesspools." "The better sort of houses, which have drains to conduct the water away, have generally only common privies, emptied frequently, much to the annoyance of the neighbours; and sometimes, this being too long delayed, the soil floats into the yards of the adjoining premises." The River Cann, since the construction of sewers, had been in dry weather covered with very offensive scum.

"In the market place is a conduit supplied with water from 'Burgess's well,' near the upper entrance to the town. From it $4\frac{1}{2}$ gallons a minute are said to flow. Tanks have been constructed since 1841 for

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the storage of water from this conduit in case of fire. Artesian well sunk through the London clay have been made for the public baths and by eight or nine private individuals." Other wells sunk into the superficial strata supplied a larger number of houses. But to a large proportion of the houses of Chelmsford there appears to have been no water supply but such as was fetched from the public sources, and this to have been scanty and hard.

Paving and cleansing.

"Several of the courtyards are unpaved, and are in a dirty and unwholesome condition." "Many of the courts are entered by narrow passages from the public street, and others have no openings in the further end, and are therefore very defective in ventilation. The removal of dust and refuse is in these courts much neglected, and some houses are very deficient in privy accommodation of any kind."

Sanitary work.

Works of sewerage and water supply were commenced in Chelmsford in 1853, and were mostly completed in that year.

Sewerage.

The plan of sewerage separates great part of the storm water from the drainage of houses, the former going off by surface channels and by superficial culverts to the river; the latter being conveyed in pipes to a pumping station in Moulsham at the lowest part of the town. From 1853 to 1858 the sewage was discharged, as well as the surface water, from this station into the river, but it was found to give rise to many complaints, and then filtering tanks were constructed, the liquid part only discharged into the river, and the solid mixed with the town ashes and sold to neighbouring farmers. During 1866 a better use of the sewage has been made; none now enters the river, but the whole is employed in the irrigation of 60 acres of land adjoining the town. But since 1858 no complaints have been heard about the state of the river, and only occasional nuisance appears to have been caused in the removal of the solid product of the manure filters.

The soil sewers of Chelmsford are of pipe, with the exception of the outlet culvert into the tank, and that is of brick, 15 inches in diameter and 6 feet below the surface. From a higher level of the tank runs an overflow pipe into the river. The mouth of the outfall sewer into the tank is closed by a sluice, which can be put down when pumping is not going on, and the sewage then backs up in the outfall sewer. In practice the power of the engine does get exceeded in wet seasons, and when the outfall is under water certain cellars are flooded by the backed up sewage. The public sewer pipes range in size from 12–6 inches, and in depth below the surface 3 to 12 feet. House drains are commonly 6-inch pipes. The sewers are ventilated by certain rainwater pipes on the higher levels of the town, and not by any openings on the street level. They are not flushed, but are said to keep quite free from deposit and very rarely to get choked; their incline is commonly 1 in 100. All inlets to the sewers in courts are protected by iron D traps, and all waterclosets are furnished with syphons or other traps.

Effect of sewerage on subsoil.

The effect of the sewerage works in removing the subsoil water of the lower part of the town would be supposed to be considerable, when it is remembered that the sewers are deep and the soil porous, and it is known that some wells were dried at the time of sewer construction, and others by the sinking of the artesian well presently to be mentioned. Moreover, it is known that cellars which before were habitually flooded are now rarely so. But to these considerations there is a serious drawback. The soil is still (perhaps more so now than during the construction of the works) thoroughly waterlogged; sometimes, in wet seasons, the outlets of the surface sewers get under water, and cellars are then flooded by the pent-up liquid; and there is a special arrangement in the

river course to prevent the natural discharge of water from underneath the town. A mile and a half below Chelmsford, on the river Chelmar, stands a water mill, and to regulate the supply to this floodgates and a weir are constructed just outside the town. Below these in dry seasons the channel of the river is nearly empty, but the water is backed up so as to keep the river quite full in its course through the town. When wet weather comes it is intended that storm waters shall flow off by the weir, but it is at too high a level for this, and unless the floodgates are opened, the meadows round Chelmsford are quickly flooded. It appears that no one but the millowners, residing a mile and a half away, have the right to deal with the floodgates, and often before they are opened the neighbourhood of the town is under water. Hence in ordinary dry seasons the subsoil water of Chelmsford is kept artificially up, and in any wet weather there are fogs from the meadows, while in winter the town is environed on more than one side by marshy lakes.

In removing excreta.

The effect of the pipe sewer system in removing excreta and refuse from houses appears to be complete. All ditches and almost all cesspools that formerly received the soil of the town have been got rid of, and waterclosets substituted everywhere. At the sewage tank, recognizable fresh excreta were seen, showing that their removal was rapidly effected, but when the engines are not working, and in wet seasons, if the quantity of sewage (being swollen by the rainfall on roofs and courts), delivered to the pumping station gets in excess of the pumping power of the engine, the sewage stands back in the pipes up to the storm outlet on the river level.

New water supply.

The water supply of Chelmsford obtained in 1853–4, is derived from an artesian well at the pumping station in Moulsham. It is dug 200 feet through various sands and through London clay, and thence is bored to its complete depth of 568 feet, the last 200 of which are in the chalk. Its ordinary yield is 95,000 gallons a day of good soft water.* This is pumped direct into the water mains, without the intervention of any reservoir. At first the water supply to the town was constant, and waterclosets and domestic taps were supplied direct from the highly charged mains through all 24 hours. This was speedily found to be a very wasteful method, and though few houses were at first supplied, the amount of water was soon found to be deficient. It therefore became necessary to reduce the number of hours during which water was supplied, to encourage the formation of cisterns for daily storage, and ultimately to take in a new source of supply. At present (1866), in addition to the chalk supply, water is being derived from a superficial well 15 feet deep, from which, in winter, 70–80,000 gallons a day may be got, but in summer only 20–25,000. This water is very hard, and is delivered alternately with the soft water ; printed notices to the townspeople telling them on which days they may expect the one or the other. This supplementary source of supply is plainly a bad one, not only from the fluctuating quantity of the yield and its hard quality, but also from its being exposed to all the impurities that subsoil water must necessarily encounter, though, indeed, none of these appear to be in very close proximity to the well.

The same pumping engine that disposes of the sewage, raises the water both from the deep and from the shallow well. The town has been divided into three districts, to each of which water (of one or the other sort) is delivered for four hours daily; for the remaining 20 hours, unless there are means of storage, the houses are without water.

* There is no analysis of the water, but in answering about subsoil dryness the surveyor stated that certain surface wells had been dried by the sinking of the artesian well.

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Storage of

Some houses have got cisterns erected for domestic supply, but these are generally the better class of houses, and are frequently contrived for the storage of soft and for the exclusion of hard water, people using their own pump for drinking water. In poor districts, into which the water pipes are universally brought, but where cisterns are almost always absent, the tenants frequently catch a pan full of the hard water for drinking, and tubs full of the soft for washing, and store this little quantity as best they may in their houses, until the next time the hard or soft water comes on. Cisterns or butts have recently been erected for supplying waterclosets with water, and there are now few closets that have not such an arrangement, but the butts are small and neither intended nor adapted for any other supply than that of the closet.

paving and

The streets of Chelmsford were improved in their paving and channelling after the works of sewerage and water supply were finished. The courts of the town are mostly gravelled, and some footways also are made of gravel with a granite curb. These gravelled areas are apt to keep wet for some time after rain.

cleansing.

For removal of dust and refuse and for the scavenging of streets the Board of health employs its own servants. Every street is visited every day, and there should be no difficulty in getting rid of the refuse. Fixed dustbins are provided in all better-class houses, and in the courts of the town public dustbins have been provided by the board. But ashes and house refuse are permitted to be used on the little gardens of the poor folks or to be sold by them to the brickmakers, and hence it has resulted that the dustbins are not used as they should be, and that nuisance from accumulation of rubbish is frequently met with.

Lodgment.

The conditions of lodgment of the inhabitants of Chelmsford have not materially changed in the past 20 years. There never was notable overcrowding, and such as did exist exists still. Houses are not often sublet, but some few are tenanted by some two or three families, with two or three rooms to each family, and in a very few instances single rooms are let out day and night to separate families. Besides the addition of new closets and other outside conveniences, the structures of houses have not been dealt with by the board. Old dilapidated wooden houses have been tenanted as long as they would hold together, and houses where there was no through ventilation remain without any. Common lodging-houses, however, have been regulated and were found in very good condition.

Summary of improvement.

It will be noticed in the foregoing account that while very much has been done for the improvement of Chelmsford, there is to each sort of work some drawback from complete efficiency. Sewers have indeed replaced the old cesspools, but they have discharged their liquid parts till quite lately into the river close to the town, while the full removal of damp and subsoil water has in no wise been obtained. The water supply again has been scanty and eked out from a very undesirable source.* Courts and yards have not been kept completely dry and clean. There has been no particular change in the interior conditions of houses.

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* The local board has in contemplation to obtain a further supply of water. They have been advised that on engineering grounds it will be easiest to take the river Cann high above the town and deliver it after filtration. Certainly from what could be seen of the Cann at Chelmsford, where it was polluted by various distant mills and factories, the source of supply, to be pure, would have to be sought a very long way up that stream, and probably it would in no case be a desirable water to take. A better but a limited source of supply has been suggested in a spring, which lies above the town level, and which appears to arise in a situation not liable to organic contamination. But the purity and hardness of this water, the certainty of its yielding the estimated quantity of 80,000 gallons a day, and the sufficiency of this supply if it were certain, are all points that will have to be accurately considered.

Per 10,000 of total Population yearly.	Before (10 years, 1843–52)	During (2 years, 1853–4)	After (11 years, 1855–65)
	execution of Sanitary Works.		
Deaths from all causes, all ages - - - -	$196\frac{1}{3}$	208	215
All causes, under 1 year -	44	$43\frac{1}{3}$	$42\frac{3}{4}$
Males - -	23·7	20·2	24·0
Females - -	20·3	23·2	18·8
Epidemic diseases:—			
Smallpox - - all ages	2	—	$0\frac{3}{4}$
Measles - - „ -	$4\frac{1}{3}$	$2\frac{1}{2}$	2
Scarlatina - - „ -	$2\frac{3}{4}$	$2\frac{1}{2}$	$10\frac{1}{2}$
under 5	1·5	0·0	5·0
over 5	1·3	2·5	5·5
Diphtheria - - all ages	—	—	$6\frac{1}{3}$
Whooping-cough - „ -	5	$7\frac{1}{3}$	$5\frac{1}{2}$
Croup - - - „ -	$2\frac{2}{3}$	$0\frac{2}{3}$	$2\frac{1}{2}$
Erysipelas - - „ -	2	$1\frac{3}{4}$	2
Rheumatic fever - „ -	$0\frac{3}{4}$	$1\frac{1}{4}$	$0\frac{3}{4}$
Ague - - - „ -	$0\frac{1}{3}$	—	$0\frac{1}{3}$
Continued fevers, probably little or no typhus - - „ -	12	$12\frac{1}{3}$	$12\frac{2}{3}$
under 5	1·7	3·7	1·0
over 5	10·3	8·6	11·6
Diarrhœa - - all ages	7	8	8
under 5	5·3	3·7	6·1
over 5	1·6	4·3	1·8
Cholera - - all ages	(In 1849, 4)	(In 1854, $3\frac{2}{3}$)	(In 1866, 0)
Dysentery - - „ -	$0\frac{2}{3}$	$0\frac{2}{3}$	$0\frac{2}{3}$
Phthisis, all ages and sexes -	$32\frac{1}{3}$	$30\frac{1}{3}$	$32\frac{2}{3}$
Males, 15–55	13·1	12·2	11·1
Females, 15–55	11·6	11·0	13·1
Lung diseases, all ages and sexes.	$23\frac{1}{3}$	$25\frac{2}{3}$	$29\frac{1}{4}$
0–5 both sexes	9·6	8·0	14·2
15–55 males -	2·0	1·8	1·6
15–55 females -	1·0	3·1	1·3
over 55, both sexes -	10·1	11·6	11·6
Brain diseases, all ages and both sexes.	$28\frac{1}{4}$	$24\frac{1}{3}$	$30\frac{2}{3}$
0–5 both sexes	15·3	8·0	13·7
5–35 „	2·3	3·0	3·4
35–55 „	1·9	3·6	2·4
55 upwards „	8·7	9·8	11·1

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The mortality statistics of Chelmsford have been examined for the sub-district * for the 23 years 1843–65; giving 10 years before the chief sanitary works in 1853–4, and 11 years after. Correction has been made for persons dying in the union workhouse, but not belonging to Chelmsford parish.

Change in death-rates from various diseases.

There has been no improvement in the public health of Chelmsford as indicated by the death registers. The last three or four years have indeed had a comparatively small mortality, but not lower than that of many years before the local board of health existed. And on the mean of years before and after the execution of sanitary works, the gross death rate has increased from 196 to 215 in the 10,000 yearly. The mortality of infants under one year old from all causes has been very closely stationary.

Of the more contagious epidemic diseases, small-pox and measles have been less fatal, whooping-cough equally fatal, and scarlatina greatly more fatal of late years, comparing the period since 1854 with 10 years before 1853. Diphtheria, too, has in the more recent period been observed and has caused a very large relative mortality—larger for the population of Chelmsford than in any other town visited for the present inquiry. Fevers, which in the case of this town may be taken as wholly typhoid, have been exactly of equal fatality (population for population) in each of the three periods, before, during and after the works of drainage and water supply. Considering those deaths from fever only which occurred in persons over five years of age, there was a slight reduction during the two years that the works were going on, but since then the mortality has returned to its previous rate. This is after excluding all deaths from fever (and they were numerous) that occurred in the workhouse among persons belonging to outlying parishes. Diarrhœa has been at every age about equally fatal before and after the public works. Cholera which was fatal to three persons only in the epidemic of 1849, and to only two in 1854, has produced a number of sporadic deaths (at least a number of deaths have been registered under this name) of late years. In 1857–65 the deaths of 17 children under five and of two older persons were ascribed to this cause. But in the recent epidemic of 1866, it is satisfactory to report that no deaths have been ascribed to cholera.

Consumption has exhibited exactly the same rate of prevalence during the periods before and after the improvements of the town, and this equally whether the disease be considered as to its total fatality or as to its death rate at working ages only.† Lung diseases have appeared notably increased in fatality; this, however, is solely among young

* The little parish of Widford, with 250 inhabitants, has got included with Chelmsford, in the sub-district whose mortality returns have been investigated. The error thus introduced is manifestly of no amount or consequence. On the death registers of this sub-district the Chelmsford union-house plays a very important part. This house is for a large number of parishes; Chelmsford is the chief of these, though it scarcely contains more than a quarter of the entire population of the union. In all statements of mortality the deaths of persons in the workhouse belonging to other parishes than Chelmsford (with Moulsham) have been deducted, both in the totals and in the statements as to cause of death. The deaths thus deducted have reached in some years nearly to a quarter, and frequently to nearly a sixth, of the entire registered mortality of the town. They have all been taken out; although, seeing that many of them were from causes like fever, erysipelas, diarrhœa, it is possible that many of the fatal diseases (if the circumstances of each such case could be learnt) have been contracted within the house, and have nothing at all to do with the parish from whence the person was brought.

† As between males and females a difference of very small magnitude is to be seen. Men between 15-55 have had their consumption mortality reduced, and women have had it increased, but the degree of either change is very inconsiderable.

children, the better diagnosis of whose complaints is apt to be a disturbing cause in registered mortality from these causes. Brain diseases, especially convulsions in children, have (possibly for the reason just hinted at) been less frequently returned as a cause of death. In persons above five years old the mortality from this class of complaints has distinctly become greater.

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ELY.

Previous sanitary condition.

From Mr. Lee's report of his preliminary inquiry under the Public Health Act, the following appears as the state of the city in 1849 :—

Site.

" The inhabited part of the city stands on elevated ground, with a south-eastern aspect. It is situated nearly on the southern extremity of the 'Isle of Ely,' and on the river Ouse, which is navigable for barges. The threshold of the cathedral is more than 70 feet above the river, and from thence the ground rises in all 27 feet more, so that the site of the town is very favourable for the discharge of surface water. The adjacent fenland is drained by steam power."

Soil.

" The depth of surface soil in the high parts of Ely varies from 1 to 3 feet, then a subsoil of sand about 6 feet, beneath this there is often found a concretion of sand forming a thin stone from 1 inch to 2 feet thick. Below that is another bed of sand which is quick where it has not been drained. The water-bearing stratum lies on the impervious Kimmeridge clay. Many of the pump wells are supplied from this source, which being near the surface is liable to failure from various sources and to pollution. The soil and subsoil in the fens is bog earth or peat, with clay below. In six years 1840–46, the maximum annual rain fall of Ely was 34·3 inches, and the minimum 20 inches."

Construction.

" Generally speaking, Ely is not closely built." " I do not recollect " any *cul de sac* built up at the end. The greater part of the city admits " of good street ventilation. The courts and back premises, however, are " very much confined." " The public highways are kept in good con- " dition, but the surface in a great majority of the courts is entirely " unpaved, and some little better than quagmires." " There is no " cleansing of the highways except what is done by the surveyors, and " that is only in the way of repairs." The courts were very ill-cleansed.

Drainage.

The drainage of the city had been partially but very inefficiently carried out, and more than half the streets had no drainage whatever. Very numerous complaints on this score were made to Mr. Lee. Houses, courts, and private property in general were not drained, the sewers having been made by the highway surveyors for the purposes of the roads. The town sewers lay from 1 foot to 8 feet deep. Some

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cellars could not be drained into these sewers, and were flooded with stagnant water and privy oozings.

The privies throughout the city were connected with cesspools in the porous soil, which had sometimes an overflow into the town drains. These cesspools were not usually connected with ashpits; they were emptied at intervals of several years. Many were very offensive, and the wells and cesspools appeared to exchange contents with great facility. There were very few waterclosets, and they sometimes drained on the surface. Besides discharging into cespools, other privies discharged (directly or along the surface) into ditches more or less stagnant.

Water supply.

The water supply of Ely was by pumps and wells, most of them were very shallow, in one district having been dried by a sewer 7 feet deep. Others, though still supplied from the surface and subsoil, were 20 feet deep. They were constantly in close juxtaposition to the privy cesspools, and their contents were very foul, sometimes requiring chloride of lime to destroy their stink; yet the dilute sewage which they contained was largely used for drinking. These hard water wells soon became dry, and in summer people were put to great inconvenience for want of water which then was also of especially bad quality.

Cleansing, &c.

There was no public system of scavenging or provision for emptying cesspools or removing ashes. The slaughter-houses were unpaved, had no drainage, and were found in a filthy condition.

The poor were frequently lodged in ill-constructed dilapidated cottages, with their sleeping rooms much crowded. Seven lodging-houses were examined and found in bad condition, but not then crowded. At fair times they were reported to be filled almost to suffocation.

No manufactures nor any occupational conditions existed in Ely of a character that could materially affect health. There was a great consumption of narcotics both by infants and adults.

Sanitary works.

The public work of drainage and water supply for Ely began in June 1853 and were completed at the end of 1854. In 1855 the houses began to be connected with the new sewers, and more and more were connected till they were all done in 1858.

Of sewerage.

The sewerage works comprised upwards of nine miles of new sewers, which have worked satisfactorily. For surface drainage of streets and courts a separate system was adopted, and no nightsoil or house refuse whatever reaches the storm water sewers. For soil drainage small impervious pipes were employed, some large districts being sewered by pipes no larger than 6 inches. These are trapped at every inlet, including the rain spouts, and have only a single ventilating opening by a shaft at their highest point.*

The soil sewers are flushed by means of hose from the hydrants. The main sewer of this system is a 12-inch pipe, which goes to the outfall on the banks of the river. The works here were for some years leased to the surveyor who planned them, and he manufactured there, with the addition of burnt bones, blood, and other matters, a manure which fetched 3*l.* a ton. In 1863 the board of health resumed the direct control of the outfall works

The whole town was provided with waterclosets with self-acting taps, probably only some half dozen houses remaining unconnected with the sewers after 1858. The water was laid on direct from the mains without cisterns.

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* Sewer air really does rise in this shaft, though there is no means of artificially making a draught up it.

Of water supply.

Water was supplied to Ely at the same time as the drainage works. Water is taken from the river Ouse at a point quite above the town (and 20 miles below Cambridge, which drains into it), and gravitates to a settling reservoir; from hence it is pumped up a very handsome water tower 60 feet high, at the top of which is a tank 66 feet in diameter and 16 feet deep, made of simple boiler plate. It holds 330,000 gallons of water, and this quantity is consumed every day. Iron piping (of which there are nine miles in all) conveys this water to every house in the town; it is supplied on the continuous system at the rate of 50 gallons per head per day, from which figure the only deduction to be made is for sewer flushing, all the rest being used (except what is wasted) for domestic purposes. The quality of the water supplied from the river is not first-rate, but it is the best to be had, and is a great improvement on the old well waters. Analysis in 1857 shewed that it had 32 grains of solid matter against 102 and 200 grains in two pump waters respectively; that it had 3·4 grains of alkaline nitrates against 28·9 and 36·9 grains, and 1·0 grain of alkaline sulphates against 17 and 24·4 grains in the two old sources of supply; but it had 1·34 grains of organic matter, mostly in the form of living organisms, while the old supplies had not so much impurity left unoxydized. This was before the present efficient system of filtration was adopted.

Present sanitary state.

As to sewerage.

The present state of the city contrasts strongly with that of 16 years ago. The drainage of streets is complete, and of most private courts satisfactory. The soil drainage system also succeeds perfectly in its design of carrying off rapidly the excretions and slops of the population. There is a rapid current in most pipes, and any whose incline is not quite sufficient are easily flushed, a process which is performed regularly every three weeks all through the town. In some places, indeed, when the drainage of several houses is received into very small pipes, trouble is sometimes occasioned by people carelessly throwing improper substances down the drains, but on the whole the system works very well. At the outfall, the works now consist in the separation of the solid soil by an upward filtration, while the liquid part enters the river below low-water mark. The solid part is taken out in the winter, mixed with the town ashes and road scrapings, and a bulky manure is obtained which sells for 2*s.* 6*d.* a cubic yard, and pays in great measure for the expense of dust removal and labour. Opinions differ as to whether any considerable nuisance arises from the outlet works or the muck heaps. No complaint comes of nuisance in the river.

As to closets.

The waterclosets throughout the town were found clean and fairly supplied with water, though in places at a too low a pressure to give proper flushing. The system of water direct from the main to the closet has been found wasteful: indeed it is proved that from one source and another, more than half of the water, to purify and raise which so much labour and expense are given, goes to simple and profitless waste. Acccordingly a new surveyor has recently had some small cisterns fixed to closets, in such a manner as will quite prevent waste and give better flushing to the pan.

As to water supply.

After the first execution of the waterworks, the water was passed through filtering beds of sand with 3 inches of charcoal before it was pumped up to the tank, and the water has not since been delivered to the town without being thus purified.

Recently, in 1865, a defect in the water supply arrangements has had to be remedied. The intake main from the river had lain in a trench where its joints had got loose, and thus some contamination of the water by the contents of the ditch had occurred, especially at times of flood; and as some sewage got into this trench, the town supply of

water might have been made seriously impure for a short time before the imperfection of the pipes was detected. All this has lately been remedied by laying the pipes in cement in a new trench, and covering them in to the level of the ground*.

Cleansing

Ely is now well paved and scavenged. A cart collects refuse daily from the streets and from the houses, where it is stored in moveable pails, and never accumulates for more than three days. Some large fixed dustbins are an exception to this rule, but they are not numerous. Not only are the main streets cleansed, but almost all private courts are systematically swept and washed with hose from the hydrants. Only a very few yards were found unswept and foul. Pigs constitute a source of dirtiness in the town. Probably more of them are kept than formerly, and their manure heaps are frequently a nuisance. Encouragement is given to pig-keeping by the system of allotments.

And nuisance removal.

The removal of nuisances is managed under the Nuisances Removal Act by an inspector, who calls in the services of a medical officer of health as he judges them to be required. The health officer exercises no continuous functions. The board have not adopted any code of byelaws, and occasionally find their proceedings hampered by the want of such. The principal nuisances now met with, and they are only occasional, are pigs kept in improper situations, accumulations of ashes and pig manure, and choked inlets to drains. The interior of houses is not inspected, but they appear to be kept fairly clean. There is no known overcrowding; no houses are registered as common lodging-houses; it is believed that tramps would lodge with the poorer sort of publicans, but not several in a room. In some of these respects the want of byelaws may be observed, but it is even more important to point out that in the absence of byelaws, there exists no provision for regulating the construction and arrangements of new houses.

Mortality statistics.

The mortality returns of Ely have been extracted and analysed, year by year, since 1842, by the superintendent registrar, Mr. Marshall. He was so good as to lend the originals of his extracts from the registers, in order that a separate and independent analysis of them should be made for this report. They have accordingly been put to the same statistical use as the registers of other towns, with the advantage of correction for persons not belonging to the city who died in the workhouse within the city boundaries. In estimating the population of Ely between the censuses, to get the death rates of each year, some room exists for difference of opinion as to particular periods. In the time before sanitary works, inasmuch as there is no way of settling the uncertainty, alternative figures are given. In the main, the estimates of this report agree with those of Mr. Marshall.†

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* Since the whole works have been complete, epidemics of diarrhœa have been observed by the officer of health in apparent connection with impurity of water. One of the worst neighbourhoods was observed singularly to escape diarrhœa, when the inhabitants dipped their water direct from the river. And in the union house, one department supplied with town water suffered from diarrhœa, which another that drank well water escaped.

† It is feared that the text scarcely does justice to the great care and labour which Mr. Marshall has bestowed on the mortality statistics of Ely; and that adequate expression is scarcely given to the way in which this report has availed itself of that labour.

Deaths, annually, per 10,000 of total Population.	Before 1852 (8 years)	During (6 yrs. 1853–8.)	After (6 years 1859–64-)
	execution of Sanitary Works.		
All causes, both sexes, all ages:	*a*) 239	206	$205\frac{1}{2}$
(*a*) On estimate of population regularly fluctuating between censuses.			
(*b*) On estimate of population increasing suddenly in 1845.	*b*) 228	—	—
Or, excluding all cholera deaths.	*a*) 238 *b*) 227	199	$205\frac{1}{2}$
All causes, under 1 year -	*a*) $53\frac{1}{4}$ *b*) $50\frac{1}{3}$	39	$42\frac{1}{3}$
Epidemic diseases :—	Before 1852 (10 years)	As above.	As above.
Smallpox (all ages) -	*a*) $7\frac{1}{3}$ *b*) 7	0	0
Measles ,, -	*a*) $3\frac{2}{5}$ *b*) 3	$3\frac{1}{3}$	$0\frac{1}{5}$
Scarlatina ,, -	*a*) 4 *b*) $3\frac{3}{4}$	$1\frac{1}{2}$	$12\frac{2}{3}$
Diphtheria ,, -	*a*) — *b*) —	—	$3\frac{2}{3}$
Whooping-cough ,, -	*a*) $2\frac{2}{5}$ *b*) $2\frac{1}{4}$	3	$2\frac{3}{4}$
Croup ,, -	*a*) $2\frac{1}{6}$ *b*) 2	$0\frac{3}{4}$	$1\frac{1}{2}$
Erysipelas ,, -	*a*) $0\frac{2}{3}$ *b*) $0\frac{2}{3}$	$0\frac{5}{6}$	1
Rheumatic fever ,, -	*a*) $0\frac{1}{10}$ *b*) $0\frac{1}{10}$	$0\frac{2}{5}$	$0\frac{1}{5}$
Ague ,, -	—	$0\frac{1}{5}$	—
Fevers ,, -	*a*) 11 *b*) $10\frac{2}{5}$	$8\frac{1}{5}$	$4\frac{1}{2}$
,, over 5 years only -	*a*) $8\frac{1}{2}$ *b*) 8	7	$4\frac{1}{2}$
Diarrhœa (all ages) -	*a*) 4 *b*) $3\frac{3}{4}$	7	$4\frac{1}{4}$
Cholera ,, -	(In 1847,4)	(In 1853, 16.) (In 1854, 28.)	(In 1866, $2\frac{1}{2}$)
Dysentery ,, -	—	—	—
Epidemic influenza ,, -	*a*) $1\frac{3}{4}$ *b*) $1\frac{2}{3}$	$2\frac{1}{3}$	$0\frac{1}{5}$
Phthisis, all ages, both sexes -	*a*) 33 *b*) 31	$25\frac{3}{4}$	$16\frac{3}{4}$
Lung diseases, all ages, both sexes.	*a*) $17\frac{1}{2}$ *b*) $16\frac{1}{2}$	$14\frac{2}{3}$	19
Lung diseases, under 5 - -	*a*) 10·4 *b*) 9·7	7·5	8·1
,, over 5 - -	*a*) 7·1 *b*) 6·8	7·1	11·0
Brain diseases, all ages, both sexes.	*a*) $20\frac{2}{3}$ *b*) $19\frac{1}{2}$	$18\frac{2}{3}$	18
Brain diseases, under 5 -	*a*) 10·5 *b*) 9·9	6·7	7·2
,, over 5 - -	*a*) 10·1 *b*) 9·5	11·9	10·8
Old age, both sexes - -	*a*) $11\frac{2}{3}$ *b*) 11	$17\frac{2}{3}$	$15\frac{1}{2}$
Causes not assigned - -	*a*) $24\frac{1}{2}$ *b*) 23	$4\frac{3}{4}$	$1\frac{1}{4}$

In giving the annexed summary of results of the statistics, attention must be directed to the last line of it, wherein is indicated a very obvious fallacy. A number of deaths, amounting to 23 or 24 annually per 10,000 of the population, had no cause assigned to them in the registers in the earlier years of the twenty, which are included in the inquiry; but, by better care, these uncertified deaths have been lately reduced to only $1\frac{1}{4}$ in the same number. The effect of this would be to make the mortality returned under special heads in the earlier period less considerable than it really was, and therefore to obscure any reduction that took place after the sanitary works. Hence a slight apparent reduction of mortality from a particular cause, may mean in reality a larger reduction; a slight increase may mean that the prevalence of the cause was stationary; a large increase may in truth not have been so large as it appears, when comparison is made between the former and the later period. But in no case can there be any exaggeration of the good influence of sanitary works.

The total mortality has declined then from 23 or 24 in the 1,000 to $20\frac{1}{2}$. The declension has been pretty steady. On any computation of population, the deaths from 1845 to 1852 always, with one exception, exceeded 20 per 1,000. Since 1858, they have never, with the exception of two scarlatina years, reached so high as that minimum, and have been steadily to between 19 and 20 per 1,000 yearly. Infantile mortality has been reduced in the proportion of 5 to 4. As for the more contagious diseases, smallpox has been absent of late; measles much reduced. Scarlatina on the other hand prevailed so badly in 1859 and again in 1864, that three times the mortality of the earlier period has occurred from this disease in the six last years. Whooping-cough has been stationary.

A great reduction has occurred in the mortality from "fevers," *i. e.* from typhoid fever. Among children under 5, no death from fever has occurred since 1858, and in older persons the fever death rate has been reduced to one half the amount at which it stood before the sanitary works. Diarrhœa on the other hand appears from the register to be about equally prevalent now and formerly, and was more fatal during the sanitary works.*

Cholera which had caused scattered deaths only before 1853, produced in that year and 1854, a small epidemic mortality; in 1866, two deaths only from cholera were registered.

Consumption has been reduced to half its earlier amount. Other lung diseases, however, show a slight increase of mortality. Brain diseases have been a little reduced through less "convulsions" and such disorders being registered in children; probably if the uncertified deaths could be classified, a greater reduction would have to be recorded in the mortality from these complaints.

Although in the statistics of this report, the whole six years between 1852 and 1859 have been taken as the period during which sanitary works were going on, it is right to say that improvement in the public health is quite manifest from a time as early as 1851, when the provisions of the Public Health Act were brought to bear upon the most palpable nuisances. That this early diminution of mortality was due to greater care bestowed on the city appears probable from the fact that the mortality was not undergoing a similar reduction in England as a whole, and was at that time actually rising in the surrounding villages,

* Connected with the increased prevalence of diarrhœa at the time of the works is the fact that 4,000 cubic yards of cesspool matter had to be removed, and that some of the men in this work did suffer severely from diarrhœa.

PARISH OF RUGBY. Population (1861) 7,818.

In February 1849 Mr. Clark made to the General Board of Health a report on the sewerage, water supply, and sanitary condition of this town, from which the principal points are here extracted :—

Condition before sanitary work.

"The town of Rugby crowns the summit, and has recently began to extend a short distance over the slopes of a table-topped knoll. The town above its substratum of (stiff upper lias) clay, rests upon a thick cap of loamy gravel sand." "There is no subsoil drainage ; the gravel or sand on which the town stands is in consequence in wet seasons completely water-logged ; even where there is no sewer to account for the evil, cellars and underground warehouses are damp and sometimes flooded" by landsprings.

Situation and Construction.

"The main streets are very well ventilated ; there are some confined courts, but mostly the courts are at the margin of the town, with open fields sloping from them."

Drainage.

"There are some underground covered drains in Rugby at a maximum depth of 3 feet below the surface. They are from 18 inches to 6 inches in diameter, constructed for the most part to take off surface water only ; they are upon no general plan, and are nowhere impervious. To such of the houses as have cellars or kitchens below the street level, they must always have been a source of damp or flood, but of late years it has become the practice to turn into them the contents of waterclosets and the overflow of cesspools, and in consequence the kitchens have been rendered not only damp but highly offensive." "The street drains discharge beyond the houses into open ditches, so that at every margin of the town there is a foul stagnant ditch, the contents of which are frequently penned back by the landowner for the sake of manure." "Hence places on the very edge of the town upon the open fields are those which suffer most from miasmata and foul smell."

Cesspools.

"In the great majority of houses of the middle and lower classes in Rugby there is found a cesspool or tank open to the sky, 5 to 10 feet long and 3 to 8 broad, and perhaps 4 to 5 deep below the surface, lined with brick. Over this at one end is placed the privy, and into it all the offal, vegetable refuse, and filths of the house and stable of every kind finds its way, and there remains more or less offensive till full. In the better houses, where the quantity of ashes is greater the bad smell is less offensive. In the tenements of the poor, where the filth is more fluid, and less covered up by dry dirt, the stench is intolerable and loudly complained of." The cesspools were not always connected with ashpits. "A very small portion only of the liquid contents of the cesspool escape by the overflow when there is one. For the most part the soil escapes into the earth and pervades the gravel. In the cesspool itself the more solid parts go on accumulating often for many years."

Water supply.

"Rugby is supplied with spring water by means of wells and pumps,

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from that gravel bed already mentioned as the receptacle for the chief of the fluid filth of the town." "All the wells and pumps are within 50 feet, and the great majority of them within 5 or 10 feet of a cesspool. It is physically demonstrable that the cesspools do feed the wells, and in many cases it cannot but be that the fluid thrown into the cesspool in the morning is pumped from the well at night. Nevertheless the gravel does its work well, and the wells are by no means generally tainted, or at least the taint appears only at intervals or if the water be kept. The water is usually much too hard for washing or making tea, varying between 36° and 60° of hardness. Two if not more of the wells in the town appear to be in a shallow gravel basin upon clay, and the water is reputed to be soft, 10° of hardness. Rain-water is collected, and water is sold in dry weather."

Paving.

"The streets are very ill-paved, and both foot and roadways are largely made with pebbles that make an uneven surface. There are many direct public nuisances, many pigsties in a filthy condition in the worst parts of the town, bone-boiling places, and an ill-managed cattle market."

Lodgment.

In the dwellings of the poor much filth was witnessed, but very little distress. Some of the courts were very filthy, with cesspools, privies, pigsties, and pump packed into them. Instances of overcrowding of single rooms by large families were here and there met with. There were some few common lodging-houses in the condition that was universal before they were regulated by law.

Sanitary works.

The parish of Rugby was made into a district under the Public Health Act in 1849. Works of drainage and water supply were begun in 1851, and the sewerage works were made and connected with the houses in about three years, but the waterworks were not then satisfactory.

Of sewerage.

The outfall of the sewerage of Rugby is by a 2-foot pipe into works at the north-west of the town. Here the sewage is strained, and passes on to a circular tank, where it is pumped up and a portion of it applied to the land, being delivered through underground pipes to hydrants situated in the meadows to be irrigated and thence running through channels in the meadows. For the portion of the sewage employed in irrigation the contractor who takes it of the board pays 50*l.* a year, and does the pumping and delivering at his own expense, and a profit is understood to be got from its application to the land. The portion of sewage not required by the contractor falls on a series of filtering beds from which the fluid part runs off in a comparatively clean state to the Avon. There is no difficulty in disposing of the black solid matter on the filters at half-a-crown a load.

In the town the sewers are at an average of 11 feet from the surface, varying from 7 to 25 feet. They are impervious and cemented pipes of size decreasing from the 2-foot outfall to 6 inches; a pipe so small as this last being used for the smaller streets, when perhaps 14–15 houses may use it. The greater part of the rainfall goes off by the same system of drains, but storm water also goes along the old sewers which are utilized for this purpose. No special arrangements were made for carrying off the subsoil water. The ditches surrounding the town were all either filled in or covered.

Many houses were drained together on the block system. The sewers were all furnished with traps at their inlets, but the rainspouts left untrapped afford means of ventilation where the gradient of the sewers was small, the sewers frequently got choked and had to be opened, poked

clear with rods, and then washed out. Since 1863 flushing chambers have been erected to clean such parts of the sewers, and the drains with their traps are also washed in the courts by hose from the water mains.

All or almost all the cesspools of the town were abolished, and the privies converted into waterclosets with pans and traps. The closet were in some instances supplied with cisterns, but the greatmajority of them in low parts could only be cleaned out while the water was flowing in the mains.

Of water supply.

Water supply works consisted of a drainage area and reservoir, contrived by Mr. Rammell, but all the suggestions first made were not carried into effect. The water was pumped to the top of a tower 90 feet high, and thence delivered through iron pipes to the town. About 20 gallons per head per day were consumed in domestic use, in street watering and sewer flushing, the railway getting its own water and there being no factories. This supply was adequate except in summer and times of drought.

The water supply has been the most troublesome part of the sanitary works in Rugby. The supply got gradually less and less sufficient, the daily supply having been as low as five gallons per head per day. An artesian well was sunk to supplement it but the water proved salt and useless. The hill water was therefore laid on during the day only, the number of hours being contracted if the supply ran short, so that lately it has been on for three hours only in the morning and other three in the afternoon. Very few houses have not the town water. It is stored in better-class houses in iron cisterns or butts. In poor houses tubs or other such vessel are seen universally employed for keeping water between the times of service. Waterclosets more usually get a supply from the main, the overflow pipe being led into them as well as a supply being given by a ball-tap, but unless there is a cistern the closet is without water for 18 hours out of the 24. The quality of the hill water is not bad, in January 1864 having 12 grains of total impurity, of which $1\frac{1}{2}$ was organic, per gallon ; that from the river is good after filtration, but indifferent without this process, holding 20–30 grains (according to the state of the river) of solid matter, of which 3 grains are organic.

Recently in 1863, an Act of Parliament has been obtained for taking water from the Avon, and the works for this are almost completed. They consist of a reservoir of $1\frac{1}{2}$ acre in extent into which the river water is pumped, and whence it passes by gravitation into filter beds and to a service tank. Filtration is to be through sand and "carbide" (a black substance consisting chiefly of oxide of iron), but at present the filter has been found to choke, and unfiltered water is being pumped to the town. To do this in times of storm would be hazardous, as a brook that receives some sewage and enters the river just above, though intercepted and carried into a lower part of the river, would overflow its sluices in times of storm and might easily contaminate the source of water supply. But it is reckoned that in times of flood the supply from other sources, and that already in the reservoir, would make it unnecessary to be taking water from the river.

Of paving, &c.

The town was paved, its main streets very thoroughly, but its courts sometimes imperfectly. Byelaws were enacted to regulate common lodging-houses and slaughter-houses, to prevent nuisances, and to settle the manner of constructing new streets and houses. A medical officer of health was appointed, and the surveyor was invested with the functions of sanitary inspector.

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Present condition, 1865.

As to sewerage.

The present condition of Rugby shows considerable improvement over Mr. Clark's description of it in 1849. It is cleanlier, better paved, and its courts better kept. The town has extended by the erection of tidy houses, and there are few of the old thatched cottages left.

The sewerage works with their recent flushing arrangements act pretty efficiently; the water supply not being continuous probably causes more difficulty in keeping the drain pipes clean. The pans of the waterclosets do not often appear to get choked, though for about half the day they cannot be washed out unless by throwing water down them. No Macfarlane's closets have been put up, though this form would seem particularly adapted to the peculiarities of Rugby water supply. The method of disposing of the sewage seems to answer very well, but the comparatively limited amount of water in the sewage is perhaps one reason of its being so manageable. Some complaint is made of the river being polluted by overflow from the filter beds.

Subsoil.

The subsoil of the town does not appear to have been wholly dried by the sewerage works. It is stated that water is still got if a well be sunk 5–30 feet, 11 or 12 feet below the surface being the usual depth for water to stand at. Probably the water line is now lower than before the new drainage, but there are no data for determining this point, and the degree of lowering is uncertain. In particular places wells have been dried by the deep sewers, but not universally.

Cleansing.

The removal of ashes and house refuse appears fairly attended to, but it is done by the owners of houses, not by the authorities. In the case of courts, where to have it removed is everybody's business, dust often accumulates so as to be a nuisance. Pigs are not now numerous in the town, probably only a score or two being kept. They have been got rid of more of late years, as they have been complained of for nuisances. A bone-boiling place in Lawford Road, that was a prominent nuisance at the time of Mr. Clark's report, still remains a scandal either to the law or to the administration of the law that has failed to remove it.

Lodgment.

The six common lodging-houses of the town are found clean and well inspected. They are never unduly crowded. A return of their inmates shows an average of 43 nightly, the highest number (70) ever returned not being in excess of their proper capacity. People in the town take in single men to their rooms as lodgers, to the extent that the house will accommodate, 1–2–3 men sleeping in the same room with the family; they are taken by the week, and it is therefore held by the local magistrates that they are not common lodging-houses. Accordingly they are not supervised, and a good deal of overcrowding probably exists of this kind. In London these houses would unquestionably be called common lodging-houses, and brought under regulation as such.

Statistical inquiry.

In the statistical examination of the death registers of Rugby, the parish has been taken as the area of inquiry. No allowance has been made for persons of other parishes dying in the workhouse, but they cannot be a source of notable error, inasmuch as neither this institution nor its plan of administration has altered in the past 20 years.

Per 10,000 of total Population yearly.	Before (7 years 1845–51.)	During (3 years 1852–4.)	After (10 years 1155–64.)
	execution of Sanitary Works.		
Deaths from all causes, both sexes, all ages - - -	191	188	186
All causes: children under 1 -	$42\frac{1}{2}$	$53\frac{1}{3}$	45
Males - -	26·6	24·5	26·0
Females - -	15·8	28·8	19·0
Epidemic diseases:—			
Smallpox all ages - -	$3\frac{5}{6}$	$2\frac{4}{5}$	$2\frac{3}{5}$
Measles „ - -	$7\frac{1}{2}$	—	$3\frac{3}{4}$
Scarlatina „ - -	$7\frac{3}{4}$	$5\frac{1}{5}$	$7\frac{3}{4}$
Diphtheria „ - -	—	$0\frac{1}{2}$	$1\frac{2}{3}$
Whooping cough „ - -	$5\frac{3}{5}$	$2\frac{4}{5}$	$4\frac{1}{6}$
Croup „ - -	$2\frac{2}{5}$	1	$1\frac{3}{5}$
Erysipelas „ - -	$0\frac{1}{2}$	1	$1\frac{3}{5}$
Rheumatic fever „ - -	$0\frac{1}{2}$	2	1
Ague „ - -	—	—	$0\frac{2}{5}$
Fevers (typhoid) „ - -	10	9	9
Under 5 - -	1·0	0·5	0·5
Over 5 - -	9·0	8·5	8·5
Diarrhœa - - . -	$2\frac{1}{5}$	$5\frac{2}{3}$	$7\frac{1}{5}$
Under 5 - -	1·5	2·8	4·4 (of which in workhouse) 0·3
Over 5 - -	0·7	2·8*	3·0 0·8
Cholera - - - -	$0\frac{1}{4}$	$0\frac{1}{3}$	$0\frac{1}{4}$
Dysentery - - - -	$0\frac{1}{4}$	$4\frac{2}{3}$ ($2\frac{1}{2}$ in workhouse)	$0\frac{2}{5}$
Phthisis, both sexes, all ages -	$28\frac{1}{2}$	24	$16\frac{1}{4}$
0–5, males - -	3·1	1·4	0·5
„ females - -	2·0	1·9	0·5
15–55, males - -	7·75	9·5	6·8
„ females - -	11·8	8·0	6·1
Lung diseases, both sexes, all ages.	$28\frac{1}{6}$	$28\frac{3}{4}$	$25\frac{1}{2}$
0–5, males - -	7·5	7·1	7·6
„ females - -	6·3	7·5	6·9
15–55, males - -	2·9	1·9	2·5
„ females - -	3·15	2·4	1·0
Brain diseases, both sexes, all ages.	$25\frac{1}{3}$	$28\frac{3}{4}$	31
0–5, males - -	7·0	7·1	10·8 (Excess in
„ females - -	8·7	11·8	7·4 old people.)
35–55, males - -	1·0	1·9	1·2
„ females - -	0·9	0·5	1·5

* All workhouse.

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From this summary of the statistics of Rugby, it appears that a very trivial reduction of the whole mortality has occurred in the period after the drainage works as compared with the period before them. The absolute death rate indeed is seen not to be high (before the sanitary works it was among the lowest of any town that has been investigated,) but the nature of some of the diseases will show that the want of progress does not come from the town being free from fevers and such diseases beforehand. The disorders of children under one year have caused about the same proportion of deaths before and after the sanitary works.

Change in death-rates from various diseases.

Small-pox, measles, and whooping-cough have been less fatal of late years. Scarlatina has been stationary in amount when 7 years before are compared with 10 years after the public works. Fevers—all of which may be taken as typhoid—have not decreased to a notable extent either in infants or adults. Diarrhœa has more than trebled its deaths in the later period, and even the exclusion of a proportion of deaths from this cause that occurred in the workhouse in several recent years does not reduce the diarrhœa mortality to much less than three times its former amount. Cholera has not been epidemic in Rugby in the 20 years.

Phthisis has been distinctly less fatal, partly this is due to fewer deaths of children being ascribed to this cause, and in so far no great stress can be laid on the reduction of consumption as the term is apt to be used indefinitely to signify a marasmus of children, which is not really phthisis pulmonalis. But at working ages, in men, and still more in women, the reduction again appears, and really seems to be a fact. Lung diseases have been slightly less in fatality, adults here having profited more than children. From brain disorders a slight rise has occurred in the mortality at both extremes of life.

PENRITH.

PENRITH.—Population (1861) 7,189.

Early sanitary condition.

Mr. Rawlinson's report to the General Board of Health, gives an account of his visit to Penrith, in 1850, and contains the following statements respecting its state at that time :—

Site.

" The town stands in a beautiful vale on the Eamont and Lowther. It consists principally of one long street in the valley ; a small stream, a tributary of the Eamont, flows down the valley and through the centre of the town. This is in some places arched over and is made to receive the drainage of the streets, houses, and such works as exist in the district, skinners, tanners, &c. The business of the town is considerable, its markets and fairs are numerously attended. Penrith stands on the new red sandstone. The substratum of the town is stated to be generally sand and gravel " [interspersed with clay and doubtless alluvial. This substratum varies from 4 or 5 to 10 feet in thickness, but in some parts of the town the sandstone appears on the surface]. The average fall of rain in the six years 1835–40, was $36\frac{1}{2}$ inches, $43\frac{1}{4}$ being the highest, and $31\frac{3}{4}$ the lowest in any one year.

Soil.

Sewerage.

Sewers existed in 1850 in many public streets of Penrith, but many public streets had no sewers or drains, many lanes and courts had no drains, and very few houses had any. The sewers were principally square, built of rubble stones and cemented. They were laid out on no comprehensive scheme and were not unfrequently choked. " The

natural watercourse is turned into a main sewer, the broad flat bed of which, flowing through the town, is stagnant with filth, offensive to the smell and highly dangerous to health; each flood removes only a portion, which each dry interval tends to renew.

"Many of the yards are unpaved, and in wet weather their surface is one sheet of disgusting puddle, foul to the sight and most offensive to the smell. Nuisances of the worst description abound in the courts and yards at the backs of the houses. Many of the poor have no form of privy accommodation, and as a consequence the surface of the ground near their houses is covered with ordure." [The system of conveniences was the old privy midden, receiving ashes as well as soil.] "Imperfect drains and cesspools saturate the subsoil." Some cesspools had not been emptied for 20 years.

Water supply.

"The town is at present supplied with very hard water by means of private pumps and wells, and by one public pump and a public well. Although the scanty stream through the town has been converted into the main sewer, nevertheless some of the poor people take water for use from it. Many of the poor are put to much inconvenience for want of water. Two watercarts are employed carrying water from the river Eamont, a distance of about $1\frac{1}{4}$ mile from the town. This water which is soft, is retailed at a halfpenny for four gallons. The water of the ordinary wells is frequently vitiated by drains and cesspools. A proposal has been made to take water from the Eamont above the town, and to supply it on the constant plan to all houses, but this scheme has not been carried out.

Nuisances.

"The shambles are in the middle of the town and are used as a public thoroughfare; on the days for slaughtering, the road through is in a filthy and disgusting state. The liquid filth drains from here into the beck, and taints its water for some distance. The butchers have shops and slaughter-houses in several parts of the town; the private slaughter-houses are much complained of.

Lodgment.

"There are 18 common lodging-houses in Penrith, kept in the same manner as in other places, crowded with beds, no means of proper ventilation, no arrangement for separation of the sexes. Fever spreads in them." "The average number of lodgers in each house was stated to be about seven each night; vagrancy was said to be on the increase."

Sanitary works.

The sanitary works of Penrith were begun in 1853, and were completed in 1856; but recently, in 1862–3, they have been extended.

Of sewerage.

The sewerage works consist of a 15-inch outfall of brick, which intercepts the sewage from the beck and runs parallel with it to its discharge into the Eamont, three-quarters of a mile of the town, and it enters without filtration or other process. The storm water is mainly carried (either by the surface or through the old rubble drains, which were retained) into the beck, which remains as a sluggish open stream (often befouled) in the middle of the town. But some of the storm water from courts and housetops gets into the pipe sewers, which are said to be of inadequate size for the double service. These pipes lessen in size towards their inlets, the submains being 9 or 12-inch pipes, some streets even having only 6-inch pipes, and the house drains being 4 or 6 inches in diameter. The general depth of the street sewers averages 7 feet; in one place they are 10 or 11 feet below the surface. The rainwater spouts ventilate the sewers, there being no special arrangements. Means of flushing from the beck and the watermains were provided. Groups of houses are drained together on the "back" or "block" system. A majority of the middens were at the same time converted into waterclosets, which were supplied direct from the main water pipes.

Appendix.

No. 2.
On Results of Works, &c., for promoting Public Health, by Dr. Buchanan.

Penrith.

Of water supply.

The public water supply of Penrith was taken from the river Eamont at a point above the town, and before it has met with any contamination from villages on its banks. A constant supply of pure water has thus been got. The water is raised by water power, or by an engine, into a covered low service reservoir, with a smaller reservoir for high service. The water is not filtered, but is as pure as the Eamont flows out of Ulleswater, and is not thick even in times of flood.

The water supply was shortly found to be inadequate to the wants of the town, and much care was given to discover the cause of it. The higher districts of the town were especially ill supplied, and the want of pressure was supposed due to leakage. It was not until an extension of the waterworks, at much expense in 1862, that the cause of this inadequate supply was discovered, and then it proved to have been in existence from the beginning of the works in 1853. It was found that some logical and consistent opponent of the sanitary measures that were then being adopted had privily inserted into one of the water mains a 5-feet pole, and had fixed it there with wedges. By degrees this pole had got accumulations round it, and the water supply had become scantier and scantier.

In 1862 some new sewerage works were also done in Penrith They consisted of taking the pipes into some streets that had sprung up around the town, and in connecting houses with the drainage system.

Effect on subsoil and in removing excreta.

The present condition of Penrith shows an improvement on Mr. Rawlinson's description of it 15 years ago, but there is still room for much more. The beck is still in parts an uncovered dirty stream, receiving various filth and the drainage of some middens. The sewers act well, though the arrangement of draining courts into them causes an inconvenience in times of storm, the pipes being put under pressure and water occasionally flowing up through the manholes. The water of the subsoil does not appear to have been notably reduced. A letter from Mr. Watson, who has the best information on this point, states, "I do not know of " any instance of a decrease of water in wells. I have, however, known " cases where wells had been abandoned after the waterworks supply " came into use, and in which water had afterwards risen and had flooded " cellars previously dry, for the cellars had been drained by the deep " sewers of the town." The arrangements for flushing the sewers are used once a month or oftener, some parts nearly level being flushed once a week, and thus the sewers are kept in practice quite free from deposit. No practical difficulty comes of the block drainage plan.*

A notable deficiency of privy accommodation still exists. A case was observed of one privy serving for 8 or 10 houses, several of which held more than one family; another case was mentioned of a court having one privy only for 72 people; and a third instance was seen where a family had to go round the corner to the next street but one.

Present state of privies and waterclosets.

Recent regulations have forbidden waterclosets to be newly constructed unless provided with cisterns, both to prevent waste and to allow of better flushing. Of 356 waterclosets in the town, 45 have cisterns, the rest having the old bibcock or a screw tap on the water main, and being frequently supplied under very inadequate pressure. Since the appointment of the present surveyor the old midden has been looked on with more favour; not that any watercloset has been actually abolished, but the midden is considered more adapted to the notions of poor people, and there has been no desire to remove them when there was a back yard; but the surveyor himself preferred

* The clumsy work of private builders was insisted on as a cause of defective house drainage, and it was pointed out that the law does not require the builders to give the local authority opportunity for inspection before the pipes are filled in. The same difficulty has been met with in certain London districts, and at Croydon.

waterclosets when the courts were very confined. In fact, a majority of the poor houses are supposed to have their privies still connected with the old style of midden, but no statistics on the point could be had. Where the midden is retained it is mostly flagged at the bottom. It is not as a matter of course drained unless it is reported to be wet; many were actually seen in a wet unflagged offensive state, and one such served for 8–10 houses, some of more that one family. The middens are emptied by a contractor, who has to be applied to as he is wanted, and who objects to render to the board an exact periodical account of the work he does. But in practice, middens are kept till they are full, or till it is worth a farmer's while to buy their contents. The dust and house refuse of the town is either retained in large pits (with or without soil) till full, or else they are placed in moveable boxes and emptied twice a week by the public cart. The streets are regularly scavenged and kept in good order; most courts too are paved and fairly clean. *Cleansing.*

The water supply of Penrith is now ample and good. Forty and more gallons is the present allowance per head per day, but from this amount a deduction must be made for the railway which is a large consumer, and for some manufacturing purposes. A great deal of the water runs merely to waste; many houses and courts have outside taps, a plan which has been found to conduce greatly to waste, and is being changed for taps within houses. If not to flush the pans of closets, still for other purposes the pressure is now satisfactory, smaller pumps of greater power having been supplied for the high service than were in use before 1862, when the high service, indeed, had from one cause and another totally failed for some four years. *Present supply of water.*

The surveyor is the officer appointed to look after nuisances, but a separate inspector sees after the common lodging-houses. The interior of ordinary poor houses is not usually supervised, even if sublet and if there be contagious diseases there; but cleanliness is encouraged by lime being given and brushes lent to the poor. A case of overcrowding was recently prosecuted successfully on two medical certificates under the Nuisances Removal Act, a fine of 2*l.* was imposed and the numbers were reduced. There are eight common lodging-houses registered for 121 lodgers, kept in good order. Overcrowding either of the lodging-houses or by subletting of other houses, is not common in this town. *Lodgment.*

Not much can be said therefore for the improvement in the physical state of Penrith. Everything seems to have been done by halves, the public sewering probably being the best part of the works. Quite recently a scheme is on foot for using the sewage for irrigation, after mixing it with disinfectants, on MacDougall's plan; this is the system in operation at Carlisle.

The following summary of the death statistics of Penrith for 20 years relates to the town proper. Correction has been made for people belonging to other parishes who died each year in the Union House. The only fallacy that needs to be guarded against in the use of the appended statistical tables (and of this summary) is that numbers of people, especially children, have died without any medical certificate of the cause. These uncertified deaths have numbered 18 per cent. of the whole, and in the earlier years the proportion was usually greater; thus in 1847 out of 206 registered deaths, 63 (or 30 per cent.) were uncertified. Popular names which have often no definite meaning are frequently assigned as the cause of death in such instances. Fallacies from this source being met with more in earlier years, would tend probably to an under estimate of any improvement that may have taken place in the public health. *Mortality statistics.*

Deaths per 10,000 of Population at all Ages.	Before (8 years 1845–52) execution of Sanitary Works.	During (3 years 1853–5) execution of Sanitary Works.	After (9 years 1856–64) execution of Sanitary Works.
All causes, all ages, both sexes	253½	279	250
All causes, under 1 year -	55⅘	49⅔	55½
Males - -	34·7	30·0	28·7
Females - -	21·1	19·6	26·9
Epidemic diseases:—			
Smallpox (all ages) - -	3½	—	3½
Measles „ - -	3⅖	0½	4⅖
Scarlatina „ - -	3⅓	28⅓	1⅚
Diphtheria „ - -	0⅕	—	2⅕
Whooping-cough „ - -	4½	8⅓	3¼
Croup „ - -	3	0½	4½
Erysipelas „ - -	1	1⅓	1⅖
Rheumatic fever „ - -	1¾	—	—
Ague „ - -	—	—	—
Fevers „ - -	10	8¾	4½
„ under 5 - -	2·27	0·5	1·1
„ over 5 - -	7·6	8·2	3·45
Diarrhœa (all ages) - -	3⅚	2	4⅚
„ under 5 - -	2·5	2·0	4·33
„ over 5 - -	1·35	—	0·5
Cholera (all ages) - -	1¼ (all in 1 year, 1846 when 9·4).	— —	0⅙ (in 1859, when 1·9).
Dysentery „ - -	1⅓	—	0⅔
Phthisis, all ages, both sexes -	39⅓	37¾	37½
Under 5, both sexes -	4·4	4·0	1·7
15–55 { Males -	13·4 }	14·2 }	14·1 }
15–55 { Females -	14·4 }	19·1 }	18·5 }
Lung diseases, all ages, both sexes.	27⅖	31⅓	24⅚
Under 5, both sexes -	10·0	10·2	13·0
15–55 { Males -	0·8 }	3·4 }	2·0 }
15–55 { Females -	2·7 }	2·0 }	1·1 }
Brain diseases, all ages, both sexes.	36¼	36¼	34
Under 5, both sexes -	19·1	18·5	14·7
35–55 { Males -	1·33 }	1·5 }	3·5 }
35–55 { Females -	2·1 }	3·0 }	2·2 }
"Old age," both sexes, total -	20⅗	27⅘	34⅗
Over 80 { Males -	4·0 }	4·9 }	7·1 }
Over 80 { Females -	6·8 }	6·8 }	8·1 }

It will be seen that the total mortality has undergone no appreciable reduction. The deaths of infants under one year old are stationary. Measles shows a small increase. Scarlatina was prevalent during two of the years during which the public works were being carried out, and its subsequent mortality has been low. Whooping-cough has been triflingly reduced in a similar manner. Fevers have declined from 10 to $4\frac{1}{2}$ in the 10,000 annually. Diarrhœa on the other hand (exclusively children's diarrhœa) has somewhat increased. Cholera could scarcely be called epidemic at any time. It caused a few deaths in 1846, and only one since.

Deaths from phthisis appear to have been slightly reduced, but at working ages they are rather more numerous, and any reduction is among children under five. Lung diseases are pretty stationary in their mortality ; so are brain diseases.

In brief, except for the reduction of fevers, the state of mortality in the town before and after the public works is probably as near constant as the nature of seasons and epidemics can permit it to be.

STRATFORD.

STRATFORD ON AVON.—Population (1861) of town about 6,000 ; of whole parish, 6,823.

Sanitary condition before works.

In 1849 the following was the state of this town abstracted from Mr. Clark's report to the General Board of Health :—

Site.

"Stratford on Avon lies wholly upon the right bank of the river Avon, here a copious but sluggish stream. Besides the borough a part of the parish of Old Stratford is included in the town. The town slopes gently towards the river. The north-west or highest corner is between 30 and 40 feet above the Avon at the bridge. The lower or south-eastern district in front of the river is within reach of an extraordinary flood. South of the town towards the church the ground near the river is somewhat higher. Below the town is a milldam by which the water is penned back 7 feet, and which is a material though most ancient injury to the drainage of the lowest part of the town."

Soil.

"The subsoil of nearly the whole of the borough is gravel, about 14 feet thick, resting upon lias clay. That part of the parish between the borough and the canal rests at once upon clay and is equally ill drained with the rest [see infrà.] It is not a place of any manufacture or of much trade. I have met with no case in which the connexion between damp and dirt and sickness and increased expenditure has been more clearly established."

Sewerage.

"The town is deficient in sewerage. Some shallow surface drains, on an irregular plan, have been constructed, none being deep enough to drain a cellar. However, they are allowed to receive a portion of the overflow from various cesspools, the direct consequence of which is the ascent of offensive effluvia through the gutter grates."

"The town much needs subsoil drainage owing to the strength of the "landsprings in its gravelly soil. In some of the streets the gardens "slope towards the houses and render them permanently damp." In the part of the town before mentioned as standing on clay "the soil "does not absorb any considerable part of the moisture and the houses

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" are wholly undrained." " Also this quarter of the town lies under " the bank of the canal, the puddle of which pens back the upland " waters, which, as it appears, find their way and rise up beneath the " foundations, and through the floor of the houses."

" There is no such thing as house drainage good or bad, and very few " of the houses contain waterclosets." The usual convenience was the cesspool or midden where soil and ashes were heaped together. " The " contents of these cesspools are disposed of by private arrangement. " There is a good demand for the manure." Habitually the cesspool was undrained, and either remained wet or its soakage ran into the gravel from whence the wells derived their water.

Water supply.

" Stratford is supplied with water by pumps and by rain. The pump " water (with one or two exceptions) is too hard for washing; what is " called the town pump yields water of 64° of hardness. It is plentiful, " and the wells are not above 10 or 15 feet deep. The wells are usually " very near to the cesspools and are occasionally tainted by them." The river water and canal water were used for washing when the rain stores failed.

Paving.

The town could scarcely be said to be paved at all. The roads and footways were in very indifferent order, many scarcely passable to carriages in bad weather.

Nuisances.

The board of guardians for the one part and the corporation for the other part of the town had " already been actively engaged in carrying " out the Nuisances Removal Act." But specimens of the places visited by Mr. Clark were " a main thoroughfare upon one side of which was a " row of muckpits, cesspools, privies, piggeries, and small enclosed " gardens, all very filthy, smelling offensively, and much complained of—" " Several crowded courts, all ill drained, the cellars damp or flooded, " the privies falling into open cesspools into which is thrown indiscri- " minately all the filth, refuse, and rubbish of each house."—" A mass " of privies, cesspools, muckheaps, and pigsties,"—repeated over and over again.

" Public nuisances are numerous. They consist of piggeries, public cesspools, and muckheaps, and slaughter-houses, of which there are seven in regular use within the town. Some of them are in a very bad state."

" The population is not very densely crowded."

Further as to soil and water.

[From Mr. Flower, of the Stratford brewery, more exact information on one or two of the foregoing points was ascertained. The highest part of the town, where the brewery stands, is on the marl of the new red sandstone formation. A well sunk into it reaches water at 30 feet from the surface, a pure water but hard from the gypsum in the marl. In most parts of the town the marl is covered by a coating of gravel averaging 10 feet thick, containing the greater number of the wells, here are much more superficial. At some lower parts of the town the water in this same gravel is soft, being probably of the same characters as the river water from which it is derived.]

Sanitary works.

The sanitary works of Stratford were begun about 1854. They consist almost exclusively of sewerage works, which, though designed on one plan, were executed consecutively, in different parts of the town, under three separate contracts. The greater portion was finished about 1859. The main sewer was the first constructed, consisting of a brick outfall, $4\frac{1}{2}$ to 3 feet, passing into the Avon below the town, without any system of filtration. The sewers that drain the town range from this to pipes 18 inches down to 9 inches in diameter. The smallest street sewer is a 9-inch pipe.

Sewerage.

The storm water passes along these sewers as well as the drainage of houses. They are laid at a depth varying, according to the height of

the ground, from 16 feet (in the mid town) to 4 or 5 feet in many other parts of the town, and at the outfall the main is quite superficial, with a fall of only 1 in 800.

As each contract proceeded, the whole of the houses of that quarter of the town were compelled to communicate with the new sewers, by 6-inch or 4-inch pipes. The communication was mainly for the removal of surface water from the yards, the drainage of cellars, the removal of slop water, and the drainage of ashpits. Only about 100 waterclosets were constructed, and this was in one of two cases, either in private houses where people had constructed forcepumps, or else in places where a common privy would stink too much, and where a closet supplied with pan and trap was therefore put, though in that case the only way of washing it out would be to throw water down it by a bucket. Throughout the town the old plan of ashpit cesspool is retained, but every cesspool is constructed of brick, is kept dry by a drain with a trapped inlet, and is supposed to be emptied about once a year by the owner.

All inlets to the drains are trapped, except certain rainspouts, which have in places been left for ventilation of the sewers. No untrapped openings have been left in the streets. The cleansing of the sewers is obtained by directing certain watercourses through them at the higher parts of the town.

Other works.

Beyond the sewers, the board of health have undertaken no other structural works. Their other operations have been confined to enacting and obtaining the partial observance of a set of byelaws, relating to slaughter-houses, common lodging-houses, the prevention of nuisances, the cleansing of ashpits and privies, the construction of new streets, and the arrangement of new buildings.

Effect of sewerage on excreta.

The drainage system appears to be efficient for the purpose of removing surface wet and house slops, and drying middens, and also in carrying off also a certain amount of solid soil from water-closets. The local authorities consider that the means of cleansing they employ (in which they are materially assisted by a stream of some 20,000 gallons daily running down from the brewery at the top of the town) keeps the sewers clean, and they are satisfied that the average amount of deposit in their sewers after a dry season has been no more than 1½ inch of mud. But at any rate the sewers do not appear to get choked at all, and great attention is paid to keep the traps at their inlets in good order. The river is befouled by the sewage where it enters half a mile below the town and here is considerable offence to eye and nose at the outfall; evidently the sewer does not carry off nightsoil before it has had time to decompose. The river used to be a beautifully clear stream.

On subsoil.

Evidence of the removal of subsoil water in Stratford comes of the interception of springs and the drying of wells. The marls of the higher parts of the town have, so far as they are porous, been affected by the deep drainage. The lower parts, lying on the gravel, have been more affected. But the old milldam still exists and keeps up water in the gravel of the lowest levels.

Present water supply.

The water supply of the town is from just the same sources as before. Mr. Clark proposed to supersede it by water from the Shottery Brook. Another scheme was proposed of a gathering ground three miles off with reservoirs for a constant supply, but neither of these schemes has been carried out. House wells belong either to single houses or to groups of several; in new houses the proportion is one to two or to four houses. A few public wells of a similar description, used for street watering chiefly, need no special consideration. The depth of the wells about the town varies from 8 to 30 feet and upwards. Of the deeper ones some appear to be sunk into the clay, but still to get water from the gravel subsoil; others (as the brewery

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wells) reach springs in the hard marl. The house wells commonly are sunk into the gravel only, and some can be readily pumped dry. Particularly along the course of the main sewers some wells have been dried. This especially happened for a year or two after the sewerage work was begun, and many wells were then deepened.

Of course the shallow well water is now as formerly exposed to the chance of contamination by cesspools, but this chance is materially lessened by the cesspools being drained. The well water is occasionally complained of, and has been found in cases to look and smell badly, but in each instance pipes were always found ill laid so that sewage had obviously got into the well. This contamination does not appear to have occurred through simple soakage of the ashpit into the well. It may therefore be assumed that the water has, on the whole, much improved in quality. Recent analyses of various waters by Mr. Kendall show much hardness from sulphate and carbonate of lime, but very little organic matter in the well water. The Avon water, and still more the canal water, are much softer, but far more contaminated by organic matters than the water of the wells. The water of the proposed gathering ground was as soft or softer than that of the river without so much organic impurity.

Present state as to nuisances.

The paving of the town, even of many main streets, is in an unsatisfactory condition, with pebble footways. No rate has been made for paving, the expense of which would be considerable. Private courts are in many instances fairly paved, but in others very badly. Ashes and cesspool soil are still removed at the pleasure of the owners. If they are a nuisance (as a great many are through their drains being choked) *and if a complaint is made of them*, the inspector of nuisances gets them removed. The nuisances of the town have not been strictly dealt with. Huge manure pits attached to hotels and stables remain. If a manure yard has got a gate to it, it may even be emptied in the daytime. Pigs continue to be a great nuisance, being kept in improper situations close to houses, and their manure being stored for months till there is an opportunity of removing it to the land, and the neighbours are unwilling to set the inspector in action about them. The butchers' piggeries, where pigs are fed on offal and refuse stored up for this purpose, are the worst. Proceedings lately taken in such a case consisted in giving a notice to remove the pigs; this was obeyed, but in a few weeks they were brought back again.

As to lodgment.

Dirty houses have been dealt with under the Nuisances Removal Act when fever has existed in them. No proceedings have been taken for overcrowding. For the last year or two there has been some undue crowding in the town, the population having increased, and two families being now and then obliged to live in one cottage until a separate cottage could be had. An old hotel had been let out in tenements of single rooms to separate families, but has been again disused for this purpose. Common lodging-houses only number three; they are fairly kept, and are only filled at harvest and fair times.

Mortality statistics.

The statistics of mortality in Stratford have been investigated with reference to the whole parish of Old Stratford with the borough of Stratford on Avon. This is the board of health district, but it comprises (besides some outlying hamlets of no moment to the inquiry) the small village of Shottery, into which no structural works have extended, and which can only have altered by the removal of nuisances. The addition of this small constant to the town does not materially effect the statistical inquiry into the altered condition of public health after the sanitary works. Half of the deaths of the workhouse have been deducted from the *total* mortality in the appended table, inasmuch as this proportion of deaths presumably fell on persons belonging to other parishes within the union.

Per 10,000 of whole Population.	Before (9 years 1845–53) execution of Sanitary Works.	During (6 yrs. 1854–9) execution of Sanitary Works.	After (5 years 1860–64) execution of Sanitary Works.
All causes, all ages, both sexes	217	213	202
All causes, under 1 year	46	$45\frac{1}{2}$	48
Males	21·7	26·0	23·75
Females	24·4	19·5	24·3
Epidemic diseases :—			
Smallpox, all ages	$1\frac{9}{10}$	—	—
Measles, „	$3\frac{2}{3}$	$8\frac{3}{4}$	$10\frac{3}{5}$
Scarlatina, „	$2\frac{2}{3}$	$14\frac{3}{4}$	$5\frac{1}{5}$
Under 5	2·1	8·75	4·0
Over 5	0·5	6·0	1·2
Diphtheria, all ages	—	$0\frac{3}{4}$	$1\frac{1}{6}$
Whooping-cough, all ages	$4\frac{1}{5}$	$1\frac{3}{4}$	$6\frac{2}{3}$
Croup, all ages	$2\frac{1}{4}$	$1\frac{1}{2}$	$0\frac{1}{2}$
Erysipelas, „	$2\frac{1}{4}$	1	$0\frac{5}{6}$
Rheumatic fever, „	$1\frac{9}{10}$	1	$1\frac{3}{4}$
Ague, „	—	—	—
Fevers, „	$12\frac{1}{2}$	$5\frac{3}{4}$	4
Under 5	1·7	1·0	0·0
Over 5	10·8	4·75	4·0
Diarrhœa	$11\frac{1}{4}$	$8\frac{3}{4}$	$5\frac{3}{4}$
Under 5	5·0	5·5	3·7 ($1\frac{1}{4}$ in workhouse)
Over 5	6·25	3·25	2·0
Cholera	$0\frac{1}{2}$	$0\frac{1}{2}$	—
Dysentery	3 ($2\frac{1}{2}$ in workhouse)	—	$0\frac{1}{3}$
	(Henceforth 7 years only.)*		
Phthisis, all ages, both sexes	$26\frac{2}{3}$	$19\frac{1}{4}$	$26\frac{1}{2}$
0–5, both sexes	1·5	0·5	0·8
15–55, males	10·4	8·0	12·0
females	12·0	8·25	11·5
Lung diseases, all ages both sexes.	$39\frac{4}{5}$	$40\frac{1}{4}$	29
0–5, males	7·3	6·5	6·6
females	8·7	4·0	6·0
15–55, males	3·8	2·5	3·4
females	2·0	3·0	1·5
Brain diseases, all ages, both sexes.	$21\frac{3}{4}$	$25\frac{1}{4}$	$25\frac{3}{4}$
0–5, both sexes	4·5	4·5	9·75
35–55, males	1·2	1·0	1·7
females	2·2	2·25	1·7

* Two years, 1845–6, being rejected because of unsatisfactory registration of causes of death.

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The most striking points in this summary statement are the slight reduction in the total death-rate and the stationary position of infantile causes of death; the increase of measles and scarlatina, both to a considerable extent, and of whooping-cough to a smaller extent; the great reduction in continued fever, which there is no reason to believe to be other than typhoid; the great reduction also of diarrhœa; the absence of more than stray cases of cholera; the stationary mortality from consumption (though with a distinct reduction at all ages during the six years that the sewerage works were actually going on); the reduction of deaths from lung diseases, partly in children, but mostly among old persons; and an increase of the convulsive disorder of infancy.

Without anticipating general considerations of the relation of these changes to the changes in the condition of the town, it is impossible not to be struck by the coincidence in the increase, rateably taken, of the more contagious diseases (an increase that is considerable and affects the three chief members of the group) with the greater density of population of the town.

ALNWICK.

Previous sanitary condition.

Site and Soil.

ALNWICK.—Population (1861), 6,494.

From Mr. Rawlinson's report on this town in 1850 the most important facts bearing on the then state of the town may be quoted:—

" The town of Alnwick stands on the south bank of the Aln, at a " considerable elevation above the bed of the river, on the boulder or " 'northern drift' here overlying the carboniferous formation. This " northern drift consists of many beds of sand, gravel, erratic boulders, " and clay, irregularly interstratified with each other; it is of variable " thickness. On the south-west parts of the town the subsoil is very " damp, being sand saturated with water resting on clay. Some of the " buildings in this district, as, for example, the Scientific Institution, " stand on piles driven into the sand." " In Clayport Street the land " has naturally a wet surface and damp subsoil, and no artificial drainage." " In the streets are public 'pants,' the local name for a construction half " pump, half fountain. There is a large open stone trough into which " the water [the subsoil water] runs, [when the pant is on a hill side, " by simple gravitation] or is pumped [when there is not such an " incline], or the inhabitants receive it direct in vessels to carry away." " "Beneath houses in Greenbat, cellars are always damp, because the " houses stand on an undrained site." " The entire surface drainage of " a large area of land falls into and through a portion of the town, the " streets being in the valleys. This is the case with Clayport Street, " Horsemarket, and Bondgate Street. It was on the south side of these " streets that cholera was most rife."

Surface drainage.

" A portion of the town was paved 25 years ago with square sets, and it answers very well. A great portion of the town is paved with pebbles from the sea-beach; this is very rough and uneven. The principal cartways are macadamized. Some of the foot-walks are formed with freestone."

" Almost the whole amount of drainage is at present over the surface " and through the town from the land above; the water and refuse in " most instances follow the natural outlet. Some few houses have " drains laid from them, but it is generally to conduct the refuse out into

" an open gutter on the side of the street. These drains are rude and " imperfect, and add to the filth of the town." " The town is intersected " by five lines of drainage [surface drainage], and the whole of the " refuse passes along these open ditches through the castle grounds " into the river."

Water supply.

" There is no general supply of water in the town. There are public 'pants' and there are public and private pumps and wells [supplied from the subsoil near the surface]. There are 10 public pants throughout the town, and all the water used for domestic purposes is carried from them, or from the pumps and wells, to the houses. In some instances the water has to be carried a distance of several hundred yards. The supply at times, when water is most needed, was said to be very deficient, and the open pants are not so clean as they might be kept."

Construction and nuisances.

" The town, seen from its principal streets, affords no indication of " its true condition. The courts, passages, alleys, and confined yards " must be inspected." " There is a considerable depth of back property " crowded with privies and middens, the drainage from which, with the " surface filth of the land above, must wash down upon the house and " find its way through long passages, and in some instances under the " floor of rooms. Privies with cesspools [connected with the ashpit] are " common throughout the town. They are placed under sleeping rooms, " betwixt houses, in all sorts of corners and confined spaces, in contact " with the walls of dwelling-houses, and in some instances above the " level of their floors. The middens are large, they are frequently con- " fined in walled spaces, calculated to hold the refuse accumulation " of 12 months, which is the customary time these festering nuisances " are allowed to stand."

In Clayport Street, in the most elevated part of the town, cholera broke out in 1849, and in this street by far the majority of deaths occurred. " The physical and visible causes to be found in Clayport " Street were large middens, foul privies, and cesspools crowded " among houses originally built much too close, privies and cesspools " within dwelling-houses and under the floors of sleeping rooms—the " land having naturally a wet surface and damp subsoil and no artificial " drainage, narrow streets, lanes, courts, and yards imperfectly paved " or without any form of paving, the surface uneven and dirty, and no " systematic cleansing, the middens left to accumulate, fester, rot, and " give off poisonous gases throughout the whole year."

" Crowded and ill-ventilated room tenements are common in Alnwick. There are blocks of houses and tenements which no remedial measures can ever make healthy dwellings, because the construction prevents free ventilation. The Tunnel is of this class of property."

" In the suburbs are 213 allotment gardens laid out by the Duke of Northumberland in 1847–8. Each allotment is of one-tenth of an acre, and is held by one of the working men of the town at a small annual rent."

Sanitary operations.

Of the character of the sanitary works executed in Alnwick it may be well to state at the outset that the eminent engineer who planned them spoke of them to the present reporter in some such terms as these : " If you are looking for a town that was in a very bad state for want " of drainage and water supply, and has now got all the advantage that " can be given by such works, go to Alnwick." And, certainly, in regard of the more important structural works the improvement is complete. These were executed under the superintendence of Mr. Rawlinson himself in the years 1852–1854, a few stray matters only remaining to be done in 1855.

Of drainage.

The drainage works consist of a system of superficial sewers for the storm water and street drainage which is discharged into the river near

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the castle ; and of a separate system of soil drainage by pipes, whose outfall is into the river, after passing a settling tank, a full mile below the town. The outlet pipe of the soil drainage system is 18 inches in diameter, laid at a fall of 1 in 319, and the sub-mains through the town are of 15 and 12 inches calibre, with a fall, just before leaving the town, of 1 in 71. From these smaller drains run into the smaller streets and courts, and the house drains are nearly all 6-inch pipes. Efficient flushing arrangements are provided ; all the inlets are trapped. The sewers are ventilated by the rainwater pipes, no special shafts or means of causing a draught of air being thought necessary.

All the houses have been connected with this system of sewerage, 1,030 waterclosets having being constructed in place of the old middens. Some 10 or 12 privies, however, have been left in various parts of the town, having the old middenstead ; their conversion into waterclosets has not been insisted on, owing to the poverty of their owners, and a doubt whether the change into waterclosets could be compelled unless the privy were shown to be a nuisance.

Waterworks.

A supply of water was obtained from springs two miles off, south of the town ; the main source yielding 75 gallons a minute with great regularity winter and summer. Some subsidiary springs have been added since 1860. The water is filtered at the reservoir. The amount per head per day, for domestic purposes, averages 23 gallons, and the supply is continuous through the 24 hours (only in very dry seasons being intermitted for a few hours in the night) and delivered under sufficient pressure. There are no houses without water, even those which keep the old midden having a supply of water for house purposes. The houses are not provided with cisterns but with taps direct from the main, and the waterclosets are also supplied from the mains with a copious amount of water.

Paving and

The paving of the town has been much improved, but many private courts have not shared in this improvement. The old middensteads, after being disused for soil, have been employed for ashpits; they have not often been covered or drained.

cleansing.

The cleanliness of the poorer parts of the town has been greatly improved, and lime for limewashing houses has been given away by the board of health, who also limewhite certain courts that are public, and employ scavengers with carts to remove ashes.

Present condition.

As to drainage.

The present condition of Alnwick appears, as regards the efficiency of its drainage, perfect ; the drains are flushed once a day, they are always free from deposit, the soil is removed very rapidly, so rapidly that at night the contents of the outfall are little else than simple water coming from waste of houses and from some springs intercepted by the sewer. The waterclosets are clean and almost everywhere act efficiently. No effluvium was observed to arise from the sewers, scarcely any even when the manholes were opened. There is no evidence of deficient ventilation of the pipes or of escape of sewer gases into houses.

The public "pants" still exist in the town, and there are some few wells still in existence. The continued flowing of these pants appears to show that in some areas under the town the subsoil water is as abundant and as near the surface now as before the drainage works ; and the readiness with which the pant water was seen to get muddy from a storm seems another evidence of this fact. Upon inquiry of several well-informed members of the local board, no opinion was given that the subsoil had been materially dried by the sewerage works.*

* The surveyor writes:—" The springs in and about the town have not been materially affected by the sewerage works. The basements of the buildings should be drier now than before the sewerage was put in, inasmuch as the sewer traps and gullies carry off the rainfall more rapidly than it would by the old imperfect conduits

Analysis had shown the water supply of the town to be good, as it certainly is sufficient, but as it appeared in the inquiry that it was occasionally somewhat turbid, and as it was of great consequence (as will immediately appear) to be sure of its quality, an analysis was made for the purposes of this report by Professor Miller, a sample being taken from the lowest point supplied by the town's water to give the opportunity for contamination if such were possible. It is enough to say that it proved a good and soft water, fairly aërated, with a small amount of organic matter and nitrates, and an insignificant quantity of ammonia.

Nuisances.

A special kind of nuisance exists to a great extent in Alnwick, and it is one which has increased instead of decreasing of late years. The great middens which at a great expense have been kept free from human ordure, and which are supposed now to serve for dry ashes only, have in a multitude of instances degenerated into a condition no less foul than when they were connected with the privy. The board undertake, indeed, to empty them upon request, and encourage as far as may be the use of small moveable ash-boxes that can be often emptied ;* but there is no compulsory emptying of the middens, and there are special reasons for their getting full of decaying refuse. Their size, in the first place, encourages accumulation, but the chief reason for keeping their contents arises from people wanting manure to put on their allotment ground, and persons who have no allotment themselves save up their refuse for their friends who have; then, to make their ashes more useful as manure, all kinds of decaying animal and vegetable matters are thrown upon the ash-heap. Again, the allotment habitually gives good feed for a pig, but the pig cannot be looked after outside the town, so he lives in the yard as near as possible to his owner, who saves up his manure and urine in the midden to return to the allotment land. The middens that receive all these abominations are undrained, and decomposition goes on for months in close proximity to inhabited rooms. There are 284 ashpits left in the town, to most of which this account will more or less apply.

Pigs.

The pigs now kept number 188, and are mostly kept in undrained and filthy sties close to houses. There are more of them than at the time of Mr. Rawlinson's inspection, which took place before the allotments had been very long granted. Some colonies of pigs are even kept as a matter of trade, in the same bad sort of sties and in the same proximity to dwellings. It is represented that the magistrates are unwilling to assist the board of health in removing pigs, even in a case of very great nuisance that was taken before them.

Changes of lodgment.

A few houses have been destroyed since Mr. Rawlinson's report, but the construction of the courts has not materially altered. Overcrowding exists to about the same extent as formerly. Common lodging-houses have been regulated, and 12 are now licensed for the reception of 64 lodgers. They are rarely full except about harvest, and disease very seldom occurs in them.

And population.

The population has not fluctuated much in amount or character, but the chief element in its changes has been the employment of some 300 workmen upon improvements at the castle since 1855. Many of them belonged to the town, but those who were imported with their families account completely for the small difference in population observed between

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and gutters. The water table may be lowered a little, but no difference is known in the depth of the standages of the pants. There are about 45 cellar kitchens in use in the town all clean and well kept, but most of them show some damp ; and the want of light and want of free ventilation render such places prejudicial to health, and highly objectionable in a sanitary point of view."

* And, in fact, the board have gradually had an increasing quantity of refuse removed year by year between 1857 and 1864.

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Mortality statistics.

the census of 1851 and that of 1861. Occupation has at no time been wanting in the town, and has been particularly plentiful since the castle works began. There are no manufactures, the regular industries of the place being trading and agricultural pursuits.

Statistics of mortality have been independently compiled for the present report from the death registers of the town. The district, wholly urban, of the board of health has been taken as the area, outlying places being excluded. Correction has been made for people of other parishes in the union dying in the workhouse. The population has been computed from the censuses with the help of local information, and there appears no source of error in the results arrived at. From the detailed accounts of mortality each year the following summary is taken :—

Deaths per 10,000 of whole Population annually.	Before (7 years, 1845–51).	During (4 years. 1852–55).	After (9 years. 1856–64).
	execution of Sanitary Works.		
From all causes at all ages - [Or excluding cholera deaths in 1849–50].	262 [232]	242	247
All causes, under two (2) years	56	51	55
Epidemic diseases :—			
Smallpox, (all ages) -	2	$0\frac{1}{3}$	$5\frac{2}{3}$
Measles „ - -	$3\frac{2}{3}$	$2\frac{3}{4}$	4
Scarlatina „ - -	$12\frac{1}{3}$	2	$12\frac{2}{3}$
Diphtheria „ - -	0	$0\frac{1}{3}$	$0\frac{1}{6}$
Whooping-cough „ - -	2	$1\frac{1}{4}$	2
Croup „ - -	$2\frac{1}{4}$	$2\frac{1}{4}$	1
Erysipelas „ - -	$0\frac{3}{4}$	$1\frac{1}{4}$	$0\frac{1}{2}$
Rheumatic fever „ - -	$0\frac{1}{6}$	$0\frac{3}{4}$	$0\frac{1}{2}$
Ague „ - -	—	—	—
Continued fevers (probably all typhoid) (all ages).	$13\frac{1}{2}$	$14\frac{1}{2}$	$8\frac{2}{3}$
Diarrhœa „ - -	7	9	$4\frac{2}{3}$
„ under 5 -	2·9	4·7	2·2
„ over 5 -	3·9	4·3	2·5
Cholera (all ages) - -	[in 1849-50, 205]	[in 1853–4, 0]	0
Dysentery „ - -	$0\frac{1}{2}$	$0\frac{1}{2}$	$0\frac{1}{6}$
Phthisis, all ages and both sexes	$28\frac{1}{3}$	35	33
Males, 15–55 -	12·3	15·1	12·8
Females, 15–55 -	11·2	13·6	15·3
Other lung diseases, all ages and both sexes	28	$39\frac{1}{3}$	$40\frac{1}{2}$
Males, 0–5 - -	5·7	8·9	7·7
Females, 0–5 - -	3·4	3·5	6·5
Males, 15–55 - -	2·5	3·5	3·6
Females, 15–55 - -	2·3	4·3	2·0

Deaths per 10,000 of whole Population annually.	Before (7 years, 1845–51).	During (4 years, 1852–5).	After (9 years, 1856–64).
	execution of Sanitary Works.		
Brain diseases, all ages and both sexes.	38	37	$29\frac{1}{3}$
Males, 0–5 - -	7·5	6·6	5·6
Females, 0–5 - -	5·5	6·6	5·5
Males, 35–55 - -	1·9	1·2	1·7
Females, 35–55 - -	1·4	1·6	1·7
Old age, all ages and both sexes	25	31	29
Males - - -	8·3	14·0	10·6
Females - - -	16·8	17·0	18·5

It is seen that the gross mortality has not much diminished, and if allowance be made for the influence of cholera in raising the death rate of the period before the sanitary works, there is no diminution at all. Year by year, since the drainage and water supply have been provided, the mortality has kept as high, and, with the allowance just mentioned, even somewhat higher than before anything was done to improve the town. The disorders of infancy caused just the same proportion of deaths to total population before and after the works. On investigating the prevalence of the chief causes of death, it appears that there has been no subsidence of any of the more contagious diseases, and that some of them have caused even an increased mortality; that smallpox has been more than doubled, while measles, scarlatina, and whooping-cough have been just as fatal in the nine years after the sanitary works as in the seven years before them. On the other hand, typhoid fever (probably the only form of continued fever seen in Alnwick) has been reduced to about two-thirds its former amount, and diarrhœa has been less fatal in about the same proportion. Cholera, which prevailed in 1849-50 so frightfully as to cause 205 deaths per 10,000 of the population, caused none whatever in 1853-4, and there has been only one stray case of the disease since that epidemic. Consumption increased from $28\frac{1}{3}$ to 33 in the 10,000 at the working ages of life, the increase being mainly among women. Other lung diseases rose from 28 to $40\frac{1}{2}$ per 10,000, the rise being most in young children. In short, after the works that were expected to bring longer life and health were completed, neither general nor infantile mortality were reduced, contagious disease did not diminish, lung diseases and consumption became more fatal, and only typhoid fever and the diarrhœal diseases experienced any important amount reduction.

Inquiries of Local Board.

The inhabitants of the town have not been ignorant of the more important of these facts. Some statistics, into which, however, several small errors and fallacies had crept, of the mortality of the town from 1824 to 1863 were made the subject of a report by five of the most experienced members of the board of health, and this committee confessed themselves puzzled and disappointed at the result of their researches. They consulted the medical gentlemen of the town on (what their statistics showed to be) the increased mortality of recent years, but they were unable to account for it. The Committee express confidence, however, in the ultimate good effect of their work, and recommend increased watchfulness in the removal of nuisances.

Recent fever.

Latterly, in 1864, the death register and the books of the infirmary

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Work for future.

showed that there had been a considerable increase of typhoid fever. Careful investigation was made into the conditions prevailing about the houses attacked by this disease. It appeared to be connected in most localities, especially where it had attained its maximum, in Victoria Place and the courts off Canongate, with foul middens and pigsties polluting the air of the confined courts, in other instances with dirty houses sublet into separate tenements; but in a few instances there was no obvious condition that might be presumed to have determined its outbreak.

Upon the occasion of my visiting Alnwick after the main circumstances of the town and the fact of its continued unhealthiness had been ascertained, the local board of health requested me to confer with them upon the state of the town, and to suggest means for improving its health. The chief practical suggestions made were that inspection should be more systematic about the poor houses and courts, being directed to the removal of nuisances and to preventing overcrowding; that byelaws should be made and enforced to insure the frequent cleansing of ashpits, and that as rapidly as possible the huge ash heaps should be systematically got rid of; that pigs should be removed out of the town; or if in any case there was legal difficulty in compelling their removal that they should be kept under regulation. But although this advice appeared to be called for, I left the town (the second one inspected in this inquiry) with the impression that I had not made out the whole of the conditions that were injuriously affecting health there.

Further experience, derived from other towns visited in the course of the inquiry, would now lead to the suggestion of some other points; what these are will appear when the total results of the investigation are stated.

Brynmawr.

Condition before sanitary works.

Brynmawr.—Population (1861) 6,334.

The following extracts from the report made in 1849 to the General Board of Health by their inspector, Mr. Clark, will show the condition of the place at that time:—

"Brynmawr is probably about 800 feet above the sea. The climate is "excessively moist, and in winter cold and inclement." "It is a town "recently built; the houses are of small dimensions, overcrowded, badly "ventilated, and with but few conveniences to secure comfort and health. "Its inhabitants are for the most part mechanics and labourers employed "in the iron and coal works in the neighbourhood." "The town has "no defined boundary and no local government. The present population "of the town is reputed to be about 5,000. [In 1851 it was found to be "5,718.] The town was originally well set out, and the streets with "some considerable exceptions are of fair width, but the houses have been "built in a hurry; they are badly arranged, ill-ventilated, without back

" premises, privies, or dust-bins. The rooms are small and dark, and the " windows sometimes not made to open. The ground floors are frequently " paved, and not uncommonly so laid as to be rendered damp or even " flooded by the rain water. This is particularly the case where the " cottages are built, as several of them are, upon the side of a hill charged " with water." "The public streets are unpitched. The footways, " where there are any, are irregular and full of holes. There is but one " tolerable sewer in the town, and most of the streets have not even a " paved gutter. The rain water forms an irregular channel in the middle " of the steepest streets, and into this or the gutter the house refuse is " thrown. The ash heaps, and even the public streets are constantly " used as privies" "To 1,000 houses there are only 145 privies, and " those very unequally distributed; some few houses having one each, " and in other cases groups of 15 to 18 are without any accommodation " at all. Filth and ashes have raised the road in many places much above " its proper level. There is no public pump or conduit, and no water " supply by means of pipes. The people go to distant and often dirty " wells and springs for water."

Sanitary operations.

The first step to the improvement of Brynmawr was the establishment in 1851 of a local board under the Public Health Act. They appointed a surveyor who has also acted as sanitary inspector, and in 1853 began structural works, comprising thorough sewerage and water supply, and the paving of the town. All these were completed in 1855.

Sewerage.

The sewers are laid in the almost impervious clay soil, at the depth of a foot or two below the surface. In some few places, however, the sewers are 12 feet below the roadway. The main sewer is of brick, 2 feet in diameter, and the submains are of smaller size, down to 12-inch, and even 6-inch pipes, receiving—even in so small a pipe as this—the soil and drainage of many houses. Everywhere the sewers have a good incline, averaging 1 in 30; there is no arrangement for flushing them, nor is any required. Special ventilators run up by the side of certain walls and some inlets distant from houses and that receive only mountain water are left untrapped, but everywhere else within the town sewer-inlets are trapped; those connected with houses having immoveable iron D traps. The outfall of the sewers is into the brook in the valley, where it is fairly carried away; though in summer, when the stream is sluggish, it is apt to stagnate and become a cause of complaint to neighbouring houses.

Works for the utilization of sewage are now in progress. It is intended to irrigate by gravitation some 20 acres of pasture land half a mile outside and below the town.

Effect of.

The effect of the sewer system in drying the subsoil is inconsiderable, the soil being for the most part impervious and the sewers being mostly near the surface. The surface, however, has been very materially dried by the sewers and by the works of paving and channelling. House refuse water and soil are effectually carried away, and excreta are to be recognized in their fresh state at the outfall. Plenty of waterclosets are supplied, even to the poorest houses, and all communicate direct with the sewers.

Water supply.

Water was supplied to Brynmawr simultaneously with the execution of sewerage works. The rainfall on mountains $1\frac{1}{2}$ mile off is collected in a reservoir formed by damming up the end of a little dingle. In 1864 this reservoir was enlarged. The supply of water is now at the rate of 20 gallons per head per day to the town, and is all used (excepting what is taken by one brewery, and what is used for sewer flushing) for domestic purposes. The system of supply is that of constant high pressure. The

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water is now delivered for all 24 hours, but before the enlargement of the reservoir, it used to be turned on for only 14 hours, or even less in dry seasons. Its pressure is not less than 200 feet in the lowest, and 120 in the highest parts of the town. The water is very pure and soft, but is apt to be somewhat discoloured by peat and to be thickish after storms. This is owing to lack of filtration, a want which it is proposed shortly to supply.

To closets.

Water is laid on to closets without cistern or service box. At first self-acting valves were supplied, but they soon got out of order and now common screw-taps are used. There is not so much waste of water under this arrangement as in most other towns where the same system prevails, as the board has taken pains, by placards affixed to privy doors and by the punishment of offenders, to inculcate the necessity of care.* Water for domestic supply is usually outside the houses in poor quarters, but in future (still to prevent waste) it is only to be supplied inside dwelling houses.

Paving

Paving works were also carried out by the local board of health in 1853–4. All roads were macadamized, footways paved, and channels pitched; latterly paved channels have been substituted for some of those that were pitched and which were difficult to sweep. All private courts and streets were set in order at the same time as the public streets; if not by the owner then at once by the board.

and cleansing.

Removal of ashes and house refuse has been contracted for; and the excellent system prevails of putting out from every house a moveable tub or bin, which the contractors fetch away daily before 11 o'clock a.m. The board has had some difficulty in getting people to be regular in this matter, but they are now much less careless than formerly. Scavenging and street-sweeping is done by men in the employ of the local board.

Lodgment.

Some little improvement has been made in the house accommodation of the people. Eight common lodging-houses have been registered and regulated. Some back to back houses have been thrown into one, and some houses that had no back openings have had doors made into them for ventilation. No houses have been actually shut as unfit for habitation, but there are several in respect of which this step is about to be taken.

Nuisances.

The removal of nuisances appears to have been efficient. Besides domestic nuisances, that of slaughter-houses has been abated by regulation and inspection, and pigs have been got rid of from near houses.

Summary of actual state.

On the occasion of the town being inspected for this inquiry it was noted that as compared with a well-kept English market town there was great room for improvement in paving, channelling, and scavenging. Many streets were deep in dirt and furrowed by watercourses, with the pavement in holes, and the area of many courts, though levelled, was not paved at all. But as compared with the common type of Welsh villages, or with its own condition in the past, there is no question that Brynmawr is wonderfully well paved and cleaned. The wideness of streets and the internal tidiness of cottages that struck Mr. Clark in 1849 are conspicuous now. The sewers, privies, and water supply were found to be acting satisfactorily, and every house to be provided with or to have easy access to such conveniences. Some courts of 20 houses with four closets and a common water-tap at the end of the court represented the minimum amount of accommodation anywhere seen. But little overcrowding was observed, though in several cases the small stone-built houses contained a lodger or a second family where there was only proper room for one

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* The closets at the highest parts of the town, when the pressure is least, do not get adequate *flushing* power under this direct service system.

family. In some few cases, however, more positive crowding was met with, a small confined bedroom with a window near the floor being inhabited, for instance, by an Irish family of three men three women and two children ; but such cases were rare.

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Results of work on health.

Respecting the influence of the various sanitary operations of Brynmawr on the health of its residents there appeared to be no doubt whatever in the minds of the authorities. The clerk of the guardians of the union in which Brynmawr is situated states, "It is matter of general remark at "the meetings of guardians that the cases of disease are more single and "isolated than they used to be, and seldom or never do those sweeping "attacks of malignant disease, prostrating whole families before them, "present themselves from Brynmawr as they used to do, and as they "still do occasionally occur in the adjoining town of Beaufort in the "same union."

Statistical results.

The statistical tables subjoined show a very plain decrease of total mortality, and it is suggested that this would have been more conspicuous still, if a different estimate of the population had been taken in earlier years. But in the absence of exact means of computing the population before 1851, it appeared wiser to take it at such an amount as to run no risk of exaggerating the improvement that the town has experienced. With a reduction of from 273 (or excluding cholera in 1849, 263) per 10,000 before the sanitary works, to 232 per 10,000 since those works, there is at any rate very good evidence of progress.

Per 10,000 of total Population yearly.	Before (10 years, 1843–52) execution of Sanitary Works.	During (3 years, 1853–5) execution of Sanitary Works.	After (10 years, 1856–65) execution of Sanitary Works.
Deaths from all causes, all ages.	$273\frac{1}{3}$	268	$232\frac{1}{3}$
Or excluding cholera	$263\frac{1}{3}$	268	$232\frac{1}{3}$
All causes, under 1 year -	$76\frac{1}{2}$	82	69
Males - -	38·5	43·0	35·6
Females - -	38·0	39·0	33·5
Epidemic diseases :—			
Smallpox - - all ages	11	1	5
Measles - - " -	$6\frac{1}{3}$	$3\frac{1}{3}$	$3\frac{2}{3}$
Scarlatina - - " -	$15\frac{2}{3}$	4	
Under 5 - -	11·9	3·3	7·3
Over 5 - -	3·8	0·6	3·2
Diphtheria - - all ages	—	—	$1\frac{1}{4}$
Whooping-cough - " -	$7\frac{1}{3}$	$8\frac{1}{3}$	$1\frac{2}{3}$
Croup - - - " -	$1\frac{1}{3}$	$2\frac{1}{4}$	$1\frac{1}{3}$
Other acute throat affections, all ages.	$0\frac{3}{4}$	$0\frac{2}{3}$	1
Erysipelas - - all ages	$1\frac{2}{3}$	$1\frac{2}{3}$	$0\frac{3}{4}$
Rheumatic fever - " -	$0\frac{2}{3}$	—	$0\frac{3}{4}$
Ague - - - " -	$0\frac{1}{5}$	—	$0\frac{1}{5}$
Continued fevers, probably none typhus, all ages.	$23\frac{1}{2}$	$9\frac{1}{2}$	$10\frac{1}{4}$
Under 5 - -	7·5	2·8	2·9
Over 5 - -	16·0	6·7	7·3

Per 10,000 of total Population yearly.	Before (10 years, 1843–52) execution of Sanitary Works.	During (3 years, 1853–5) execution of Sanitary Works.	After (10 years, 1856–65) execution of Sanitary Works.
Epidemic diseases, *continued*:—			
Diarrhœa, all ages - -	5	$4\frac{1}{3}$	$4\frac{3}{4}$
Under 5 - -	3·9	2·2	3·2
Over 5 - -	1·9	2·2	1·6
Cholera, all ages - -	(In 1849, 100)	(In 1854, 0)	(In 1866, ? 1 or 2)
Dysentery „ - -	$0\frac{2}{5}$	—	$0\frac{1}{5}$
Phthisis, all ages and both sexes	$28\frac{1}{3}$	$25\frac{2}{3}$	30
Males, 15–55	10·0	8·3	7·1
Females, 15–55	11·9	11·1	10·8
Lung diseases, all ages and both sexes.	$36\frac{1}{4}$	$53\frac{1}{3}$	39
0–5, both sexes - -	16·8	31·1	26·5
15–55, males - -	3·6	5·0	2·5
„ females - -	2·8	2·2	3·0
55 upwards, both sexes -	11·7	13·3	7·3
Brain diseases, all ages and both sexes.	66	$71\frac{3}{4}$	$47\frac{1}{3}$
0–5 both sexes	57·9	62·3	40·5
5–35 „ -	3·4	3·9	1·6
35–55 „ -	1·7	2·3	2·2
55 upwards „ -	3·0	3·3	3·0

In Brynmawr there is a very high mortality among infants under one year of age, (ascribable to causes that have been reported by Dr. Hunter) and this has only been reduced since the sanitary works in the same proportion as at other ages. All the more contagious epidemics have been greatly less fatal than before. Fevers, which in this statement may be taken as wholly typhoid, have been reduced to below half their previous mortality. Diarrhœa appears to have been stationary. Cholera, which in 1849 killed no less than 100 in the 10,000, caused no death in 1854, and no positive case of it was seen in the recent epidemic.

The mortality from consumption has not as a whole been reduced, but after exclusions of deaths of children and old people registered from that cause, a small reduction (from 22 to 18 per 10,000) is observed in the mortality among people at working ages, and males appear to have obtained this advantage more than females. Lung diseases have appeared with even an increased frequency on the death records of late years, but as the increase is exclusively among infants under five, no importance attaches to the register. For in Brynmawr, at the earlier periods over which the statistical inquiry extends, it was obviously the fashion to set down numbers of children's deaths to "convulsions" and such causes, which, as medical knowledge and certification have improved, have come to be referred to the proper disease which have convulsions and the like for their symptoms, and doubtless children's lung diseases appear more frequently now in the deaths records, without any proof that they have actually risen in fatality. Among people at working ages, the death rate from lung diseases has undergone some slight reduction, and solely

among males. Brain diseases, it has just been said, used to appear with monstrous frequency on the Brynmawr death register in children of tender years. No less than 58 children per 10,000 of population used before 1853 to die of causes registered as convulsions and the like, a number which has since been reduced to 40; but to these figures it is felt that no importance attaches except as showing the high absolute rate of infantile mortality that prevails. In adults the mortality from brain diseases remains pretty stationary.

Worthing.—Population (1861), 5,805.

Worthing.

This town was visited earlier in 1866 than other towns comprehended in the general inquiry, in order that the causes of epidemic fever that had prevailed during the previous autumn should receive investigation. On that subject a special report was made, the main points of which will be recapitulated in the present statement.

Sanitary condition before works.

Worthing was examined by Mr. Cresy for the General Board of Health in 1850.

Site and soil.

"The site of Worthing at one time formed an island sheltered by the Downs and chalk hills on the northern side. The situation of the town is low, and the mass of loam and clay on which the town stands does not rise more than 18 or 20 feet above the level of the sea. The substratum is shingle, and near the coast the water percolates into it from the sea. In the winter fogs are more prevalent than on coasts which are bounded by cliffs or higher ground. The dip of the chalk is towards the south-west, consequently the flow of water which drains from the South Downs is under the town of Worthing, and wherever the capping of loam or clay has been removed the chalk crops out most abundantly in various places on the shore. The superficial soil is a fertile loam mixed with sand.

Management.

"A Local Act of 1821 provided for paving the town for markets and for sea groyns. The beach has been injuriously affected by the discharge of sewage over it, and during the 16 hours of the day that the sands are uncovered nuisance arises to people who walk on the shore, and heaps of seaweed collected for the purpose of manure give in their decomposition similar offence to visitors. Public roads are well paved, but many that are regarded as private are only partially paved, or not at all; several of the latter in thickly populated neighbourhoods are quite impassable. The town is well lighted by gas."

Dampness of houses.

It will be seen that there were peculiar conditions favouring the action of damp upon health:—"In several houses the party-walls as

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well as the foundations are carried up with chalk obtained from the shore, which is sometimes permitted to weather for a summer before it is made use of; but this material is extremely susceptible of moisture, and when deprived of it, of again taking up a quantity equal to at least one-third of its bulk. Wherever walls are stuffed or hearted with this material, if they are near water, every cube foot will take up two gallons; therefore it is highly necessary to provide against this saturation in order to maintain the houses in a healthy state." "The cottages which have been run up for the poor are in general constructed of the worst materials. Bricks of a soft and porous nature, and badly burnt lime with which the mortar is formed; often the footings of the walls rest on the surface of the soil, and where trenches have been dug for their reception no preparation whatever made to drain off the water which invariably finds its way into them." "The basement of many houses cannot be maintained dry without the aid of pumping." "Eastward of Field Row the land has been artificially lowered, and in the winter seasons is often under water."

Sewerage.

Such sewerage as the town possessed discharged into the sea, as has been stated, by eight wooden troughs at mid-tide level. "The surface of the water in the Teville stream ditch, which is the natural drain of the neighbourhood, is on a level with the water of the ocean at ordinary spring tide." The house drainage was into cesspools constructed so as to retain liquid as well as solid contents, the overflow of them commonly passing into the trough system of public drains. And instance after instance is given of cesspools requiring to be baled out, or overflowing through inefficiency of drains from them.

Water supply.

The supply of water to Worthing was by the town pump and many private pumps and wells. Those whose depth is mentioned in the report were 18 feet deep. The supply seems to have been scanty and troublesome to obtain, but no mention of bad quality is made.

From local information it appears that the wells were sunk to an average depth of 15 or 16 feet below the loam until the surface of the chalk, with an overlying vein of sand, was reached. Of course the liability to drain contamination could not have been considerable.

There were some small and badly-arranged lodging-houses for tramps in the town.

Sanitary operations.

The Public Health Act was applied to Worthing in 1852, and between 1853 and 1856 the works of drainage, water supply, and paving, now to be described, were done.

Sewerage.

The sewers of Worthing* are pipes laid with an inclination opposite to that of the surface, and conveying their contents to a sewage well at a distance from the sea. Beginning near the beach, they are superficial, but near their outfall they are 20 feet below the surface. Houses drain by 4 or 6-inch pipes into the smaller street sewers of 6 and 8 inches, and there join larger pipes, which, receiving much surface water as well as house refuse, are continued by a brick main of egg shape (3 feet 2 inches by 2 feet 3 inches) to the pumping works at the north of the town. Here the sewage enters a tank at 20 feet below the surface and is lifted by engine power into a delivery box above the surface. It thence gravitates either into the sea at a point a little distance from the town, and this was till late years the only way of disposing of it, or,

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* The old sewers and surface channels continue to be used to carry off a portion of storm water, but they only act ineffectually, and portions of the town are still liable to be flooded after heavy rains.

being raised to a higher level, it is distributed over certain meadows in the neighbourhood of the town, and thus latterly none has gone to the sea unless it has been over diluted by storm or flushing water at a time when the fields want no further wetting. The sewers have been (with very few exceptions) wholly unprovided with ventilation or apertures to allow of the escape of compressed gases within them. Flushing for the sewers is provided by turning the contents of a water main down them or by hose from the nearest hydrant. As a rule, the sewers keep pretty free from deposit, but some of them near the head of the system are laid nearly at a level, and require much washing out to prevent accumulation in them.

Effects of

The effect of the sewer system in removing subsoil water has been considerable ; the semi-porous strata on which the town stands have been much dried, not less by water finding its way alongside the pipes than through the sewers themselves. Water from this source has given a good deal of trouble in wet seasons at the outfall works. The other great effect of the sewers, in replacing cesspools and removing all excreta, is also unquestionable and universal.

drawbacks to action of.

But here must be mentioned the drawbacks to the action of the present drainage system and the measures that have lately been taken to improve it.

Everything has depended on the pumping power of the engine. When it is not at work sewage accumulates in the well. When the sewage is delivered in excessive amount beyond the utmost capabilities of the engine there has been no outlet for it, but it has filled the well and backed up the sewers. In prolonged wet weather consequently it has happened that water (more or less charged with sewage) has regurgitated into basements of certain houses. In such a conjuncture means of relieving the sewers from the pressure of gases within them become of the greatest importance. And from the absence of such means in Worthing it has resulted that often in a wet season waterclosets smell universally and gas has been known to be forced up through their traps. Now, in 1865 the difficulties inherent in the existing arrangements were developed through peculiarities in the seasons. To begin with, during the hot weather of the early summer of that year the drains were very ill flushed, partly through the scantiness of available water supply caused by the waste of it; partly, it is suggested, through the neglect of a former surveyor. Then came an extremely wet autumn; the sewage in the well could not be kept down to its proper level; it backed up the sewers, flooding certain basements. Now the especial want of ventilating openings to the sewers appeared. Foul gases generated in the previous time of drought had no means of escape but by bubbling up through the traps of sinks and waterclosets. This was heard to occur in some houses where waterclosets were inside.

Whence fever.

The probability that this condition of things was the cause of the typhoid fever which broke out in the autumn of 1865 (the chief outbreak and the only one investigated by the council) appears to reach positive demonstration when it is added that the fever almost exclusively attacked well-to-do houses on the highest levels where the waterclosets were inside the houses, and almost entirely spared the houses, mostly of a much poorer sort, situated on lower levels, where the closet was placed outside the house. It was not so in the times of cesspools; then these low-lying poor houses were far more attacked with fever than the others. Moreover, the fever subsided as soon as openings were made into the sewers from certain houses where it had before maintained itself for months.

Provision is now made against the recurrence of this dangerous series of events by the construction of a storm outlet to the sewage tank, by

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the supply of ample ventilators to the pipes, and by more systematic flushing of deposit out of them.*

New water supply.

The new water supply of Worthing, given at the same time with the new drainage system, is derived from an artesian well, dug 65 feet (in which part of its course it is protected by an iron cylinder) and then sunk 300 further feet into the chalk. The same engines that pump the sewage also pump the water up from this well, and a mean quantity of 140,000 gallons (ranging from 100 to 180 thousand) is raised by it. The supply is on the constant system, the water mains being always kept charged at a pressure to throw water to the tops of the highest houses. A reservoir, holding 110,000 gallons, is constructed at the top of a broad brick tower, to equalize the pressure and to give water during the intervals of pumping. From the total amount supplied a deduction must be made for the railway, for sewer flushing, for brewhouses, and for some large laundries, before the domestic supply can be estimated. But if these were the only deductions there would be ample water for all purposes at sufficient pressure. Unfortunately there is a deplorable amount of waste, closet-taps being left to run all night, and water supplied by contract being used in careless fashion. In this way, too, pressure is so far diminished that the pans of closets do not get all the flushing force of water that they ought to get. But as a rule the supply of water to closets in Worthing is satisfactory; they all are furnished with pan and trap, and almost every cottage has its separate closet, neatly kept in every instance observed.

Closets.

Paving and cleansing.

Paving works were executed as soon as those of drainage and water supply were complete, and there is hardly any part of the town without good roads, channels, and footways, or in which the courts and yards are not level and clean. Only one or two places deficient in this respect were noted in inspection of all the poorest parts of the town, and the poorest houses were found to have a corresponding air of cleanliness and comfort about them. There is indeed no pressure on the house accommodation of the poor, and each family, with but few exceptions, keeps its own cottage to itself. House refuse is removed twice a week by the carts of the local board; dust and ashes are usually stored in moveable boxes between the visits of the cart, but when there is much space about houses fixed dustbins are allowed.

There are one or two registered common lodging-houses kept in fairly good condition. The Nuisances Removal Act has been carried out since 1855, but piggeries and slaughter-houses have remained in an offensive state till quite recent periods.

Mortality statistics.

The data for the following statistics of mortality in Worthing were prepared for this report by the local registrar, whose long knowledge of the town has enabled him to make them perfectly accurate, and to confine the return to deaths among persons resident in the town. The results, though based on small numbers, may be taken as quite free from fallacy.†

* Great interest attaches to the irrigating works at Worthing. They appear to be to the completest extent satisfactory both in their agricultural and financial results, But in a sanitary report it is only necessary to mention that they do not cause any description of offence or injury to health. Nor is this the place to speak of the increased value of property that has been directly brought about through the operation of the public works, but it is stated to be very considerable and gratifying to the town.

† Quite free as regards amount and nature of change in mortality; but perhaps the absolute rates are not quite correct. For the deaths have been taken after exclusion of visitors, and the population has been taken without exclusion of such visitors as may happen to have been in the town in April on the census night. Probably the few visitors noted in Worthing in April have not been materially more numerous at one census than another. But it may be observed that Worthing shows the smallest absolute death-rate of any town visited, a circumstance probably due in part to the population on which the rates are computed being taken too high.

Per 10,000 of total Population yearly.	Before (10 years, 1843–52) execution of Sanitary Works.	During (4 years, 1853–56) execution of Sanitary Works.	After (9 years, 1857–65) execution of Sanitary Works.
Deaths from all causes, at all ages - - - - -	155	163	153
All causes, under 1 year -	$24\frac{1}{4}$	23	$22\frac{1}{3}$
Males - -	13·6	13·6	11·4
Females - -	10·6	9·3	10·9
Epidemic diseases :—			
Smallpox - - all ages	3	$2\frac{2}{3}$	$1\frac{2}{3}$
Measles - - " -	$1\frac{1}{3}$	$2\frac{1}{4}$	$2\frac{1}{2}$
Scarlatina - - " -	$2\frac{1}{3}$	$2\frac{1}{3}$	$5\frac{1}{3}$
Diphtheria - - " -	$0\frac{1}{3}$	—	$3\frac{1}{4}$
Whooping-cough - " -	$6\frac{1}{3}$	$2\frac{1}{3}$	2
Croup - - - " -	$2\frac{2}{3}$	1	2
Erysipelas - - " -	$0\frac{1}{4}$	1	$0\frac{2}{3}$
Rheumatic fever - " -	$0\frac{2}{3}$	$1\frac{1}{3}$	$0\frac{2}{3}$
Ague - - - " -	$0\frac{1}{5}$	$0\frac{2}{5}$	—
Continued fevers (probably none typhus), all ages.	$7\frac{1}{2}$	$9\frac{1}{3}$	$9\frac{1}{4}$
0–5 - - -	1·8	2·2	1·0
5 upwards -	5·7	7·2	8·2
Diarrhœa, all ages - -	$4\frac{3}{4}$	$4\frac{1}{2}$	$5\frac{1}{2}$
0–5 - - -	3·4	2·3	4·4
5 upwards -	1·4	2·2	1·1
Cholera - - - -	(Epidemic, 1849, 0.)	(Epidemic, 1854, 1 case.)	(Epidemic, 1866, 0.)
Dysentery - - -	$0\frac{1}{5}$	$0\frac{2}{5}$	$1\frac{1}{4}$
Phthisis, all ages, both sexes -	$30\frac{1}{2}$	$28\frac{1}{4}$	$19\frac{1}{2}$
15–55 males - -	8·5	10·6	7·6
15–55 females -	14·0	11·9	8·2
Lung diseases, all ages and both sexes.	$14\frac{2}{3}$	$18\frac{1}{2}$	$18\frac{1}{2}$
0–5, both sexes -	6·6	4·8	4·6
15–55 males - -	1·5	0·9	0·8
15–55 females -	0·8	3·6	1·0
55 upwards, both sexes	5·4	9·2	11·7
Brain diseases, all ages and both sexes.	$24\frac{1}{2}$	$26\frac{1}{2}$	$26\frac{1}{4}$
0–5 both sexes	12·3	8.0	9·7
5–35 "	3·1	4·8	3·0
35–55 "	3·5	3·1	3·4
55 upwards "	5·6	10·6	10·1

The total mortality of Worthing has not been appreciably reduced. The deaths were 155 in the 10,000 before the sanitary works, and have latterly been 153. Deaths in children under one year of age have fallen from 26 to 22 in the 10,000 of all population. There has been

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less severe prevalent of small-pox and whooping-cough, but more of measles and scarlet fever, while diphtheria only appears on the register since the time the town was improved. Croup, rheumatic fever, and erysipelas show no appearance of change in the limited mortality ascribed to them. "Fevers" which may be taken to be typhoid fever exclusively, have increased in their death rate from 7½ to 9¼ annually per 10,000 residents. Neither of these figures is a high absolute fever death rate, as matters go in other places; but Worthing is the most striking exception met with to the general rule of subsidence of typhoid after works of sewerage and water supply.* After exclusion at each period of the few deaths set down to fever in children under 5 years of age, the rise in the fever mortality is even greater than shown by the above figures, and the rise has not resulted solely from one particular epidemic. Diarrhœa in children and "dysentery" have each more deaths registered under them now than formerly. Cholera caused no deaths in 1849, only one death in 1854, and none in 1866.

Consumption has become distinctly a less fatal disease in Worthing. In total mortality it has fallen from 30½ to 19½ in the 10,000, and after exclusion of all deaths ascribed to this cause at the extremes of life, there remain figures which show a similar proportionate decline at working ages. Both sexes have profited, but females more than males. Of women aged 15–55, the death rate from phthisis used to be 14, and only now 8¼ in the 10,000.† Lung diseases are registered as more frequent causes of death of late years, but this is exclusively among aged people. Up to 55 years of life this mortality has been even a little less than it used to be. A similar qualification has to be made to the statement that more brain diseases appear on the death books. This too is wholly among old persons; fewer children have died from convulsions and the like complaints; and just the same proportion as formerly of persons in the prime of life.

Morpeth.

Morpeth.—Population 1861 (corrected) 4,490.

Previous sanitary condition.

This was one of the towns inspected by Mr. Rawlinson. From his report, dated 1849, the following particulars of its then condition are extracted:—

Site and construction.

"Morpeth has the advantage of a site most favourable to health. The

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* The only other town where fevers have not subsided is Chelmsford, where an almost exactly similar system of sewerage prevails, where the sewers, however, are ventilated to some extent. Further mention is made of these towns in a note on the general report, page 6.

† Of course the population is but small, and a few deaths would make a difference; but on the other hand, the inquiry has extended over 12 years before and nine years after the public works, long enough to have neutralized accidental fluctuations.

" river Wansbeck forms a bend round the west, south, and east sides of " the town. The valley in which the town stands opens to the south-east " and north-west, through which a current of air is constantly flowing." " At present the town is in some measure crowded upon itself, but as " facility is now offered for building in the outskirts this evil may in " future be avoided." "There were lately several properties in the " town, the owners of which did not esteem them worth repairing, but " had permitted them to fall into decay. All these have been repaired " with one or two exceptions, and, during the last months, many persons " who wished to reside in the town have been unable to find houses." The only remains of manufactures are four tanyards.

Soil.

"Morpeth stands on the lower beds of the carboniferous formation, the principal characteristics of which are quartzose grits, with shale, coal, ironstone, &c. The stratified rocks have here been covered by a drift or diluvial deposit varying in character and depth. That part on which the town stands has about two or three feet of soil below which is a bed of very tenacious blue clay, in some parts 20 feet in depth. A section of the strata at the north-east of the town showed $1\frac{1}{2}$ feet of soil, below which followed eight feet of sand and then clay." [The inhabited part of the town stands (*a*) mainly on clay with a little surface soil; (*b*) to the north-west on a hill of sand over the clay; this is a small portion of the town only, and drains easily into the river on the one side and into the brook called Cottingburn on the other. (*c*) Near the river some small part stands on porous alluvial deposits.]

Sewerage and

"There are no effective sewers or drains in Morpeth." "Near the " market place the shops and houses have cellars under them, but for " want of proper sewers and drains they are damp and wet, and at " times they are partially filled with water." "In Water Row the " drainage from the high land behind the houses comes down into the " gardens and yards, and for want of drains the cottages cannot be kept " dry."

Privies.

"There are many confined courts and yards with privies close upon the houses, or in some cases under the sleeping rooms." Privies with middens where the soil was mixed with the house refuse were the form of convenience almost exclusively in use. "It is only recently that " waterclosets have been erected, and there are not a dozen in the whole " town at present, and, for want of proper sewers, those put up are said " to be a great nuisance." "There are no underground drains to pass " off the liquid refuse from the privies and cesspools, and the ashes " and other solid refuse are only removed at long and irregular intervals."

Lodgment.

"The cottages throughout the town are clean where the inhabitants have any facility for preserving them so." The lodging-houses for vagrants, 30 in number, were found greatly crowded about the time of harvest, unventilated, and many of them in a most filthy condition.

Water supply.

The water supply of Morpeth was derived from the river as well as from springs and wells, and from the works of a private company established in 1815. The river in the absence of floods was of great purity, as there are no houses or manufactures along its course above the town. [Some of the wells were shallow in the porous soil near the river, and their water was in fact the river water filtered through the ground from a higher point of the stream. Two other wells derived their supply from springs in a neighbouring table land.] One fourth only of the houses in the town, and these mostly of the better sort, were supplied with water from the Allery Bank works. This supply was continuous but scanty in amount. It was also to be had from standcocks in public places of the town.

Nuisances.

Byelaws of the council provided against the occurrence of accumula-

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tion and nuisance in the streets. "These byelaws have during the "last twelve months been enforced. A local sanitary committee has "regularly inspected the town and nuisances have been removed." [This appears to have been under the expectation of cholera.] "The "slaughter-houses are not regulated, the refuse is thrown on some "midden, and for want of drains the yards are fouled with garbage "and blood."

MORPETH.

Sanitary works.

The sanitary works of Morpeth, planned by Mr. Rawlinson, were carried out in 1853–56. In April 1856 they were described by Mr. Woodman, the clerk to the local board, in a report to the board. The drainage works consisted of a manure tank, 588 yards of brick and 6,200 of pipe sewer, with 27 manholes, 13 eyeholes, and 70 gullies.

Sewerage.

The whole town was included in the drainage system. The sewers worked perfectly in every way, were well ventilated, and regularly flushed and inspected. One piece of deficient main only was known of, but certain sub-mains had a bad fall, and, as they received many house drains, required frequent flushing to keep them open. House drains had been adopted very generally, and 184 waterclosets had been provided; but 233 privies of the old sort remained.

Waterworks.

Waterworks had been constructed, consisting of storage and service reservoirs which received the rainfall of 16 square miles, 6,200 yards of iron pipes with 33 valves and 45 hydrants or firecocks, all in working order. A filter bed was however wanted. The daily yield was not by one-fifth up to Mr. Rawlinson's estimate of 20 gallons a day to each person in the town. There were 2,884 people in 481 houses supplied by the water, and 755 people in 125 houses without the water, and the amount then being supplied gave 18 gallons a day for each of the 2,884 people supplied, but deduction should be made for water used for trade, for sewer flushing, and for what was wasted. In quality the water was reported very pure and good, but it wanted filtration. Lodging-houses had been regulated with the effect of improving decency and lessening crime.

But there was room for several further improvements, especially the erection of waterclosets in certain thickly peopled parts where there was no room to build privies, the more universal supply of water, and the regulation of slaughter-houses.

After 1856, the water supply of the town appearing insufficient, the construction of waterclosets was not encouraged; but more recently a good many more have been made, and more houses have been connected with the sewers.

Present state.

As to sewerage

At the present inspection the sewers were found to be acting well, but as they are in many places below the level of the river it happens that in times of flood the sewage is backed up the main sewer for 400 to 500 yards. In one locality an improvement has been made since the main works, in order to drain some courts where the fall was bad, and where fever had been common. Arrangements are made for flushing the sewers by turning the river into them, but the effect of this is to fill them with sand. Where the fall of the sewers is bad, they are now flushed from the water mains by means of hydrants, once a fortnight. The house and street drainage is by pipes of the smallest available diameter, being no larger than six inches in some smaller streets; but they are of sufficient size to carry off the storm water as well as the house refuse, there being only a single system of sewers. All inlets are trapped, usually by S traps; ventilation is by downspouts only. Waterclosets are supplied with water direct from the main, only a few having a small flushing cistern. They have self-acting taps, usually a fair supply of water, and do not get out of order. They have been adopted to super-

cede the midden in those cases where the convenience is under inhabited rooms; but in most poor courts the midden privy has been retained, not only because of the short supply of water for them but also as being more suitable to the habits of the people. These middens were seen at the inspection to be often wet, oozing, and stinking.

The cellars of the east end of the town that used to get filled with water in all heavy rains have never been flooded since the sanitary works. The lower lying streets which after a storm or the melting of snow used to be inundated now never experience this inconvenience. Thus the surface is rendered incomparably drier; but the subsoil, in so far as it was previously wet, has not been affected by the sanitary works, for the springs near the river are unaffected, and the bed of stiff clay is not altered by the impervious drain pipes with water-tight joints that are laid in it. Of course the two springs whose origin is in an outlying tableland have not been affected. The high lying tongue of sandy ground on the north-east of the town drained itself effectually before the sanitary works.

and subsoil.

As to water.

The original public water supply of 1856 has since been supplemented by an ocasional use of the earlier source at Allery Bank. This is a harder but not an impure water, supplied from a reservoir at only 40 feet above lowest parts, and is generally available when the supply in the new reservoirs becomes low; but the quantity supplied to the town in dry seasons is inadequate, sometimes not exceeding 10 or 12 gallons a head per day: the mains are then only kept charged for 14 hours out of the 24. While the supply is being taken from the old waterworks the higher parts of the town have to go without any. The proposed plan of filtration has not been carried out.

As to lodgment.

No alteration in the constructive defects of the courts has been made. Not much overcrowding by the sub-letting of houses is known to the inspector. The common lodging-houses are regulated, inspected, and not overcrowded. Four years ago, before agricultural machinery was in such common use, they used to get somewhat crowded at harvest.

As to cleansing.

The cleansing of thoroughfares appears well attended to, and an inspector looks well after the cleansing of yards and courts, and the removal of nuisances; but some private yards have still a dirty surface from oozing of privies, or from imperfect paving. There is no systematic plan of removing ashes and house refuse; the dust-bins and middens are emptied by the farmers as it becomes worth their while, or when they are found by the inspector to be a nuisance. The slaughter-houses are now all paved, mostly supplied with water, and in good condition. Pigs are not kept so as to be any serious or general nuisance.

To recapitulate, the sanitary works consist of a system of pipe drainage which takes the soil of about half the population, of a water supply for almost the whole population, and in the systematic removal of the chief nuisances. But still a great number of middens remain, and are kept only indifferently; the water supply in dry seasons is inadequate, and in paving of courts and some other respects improvement is still required. The surface has been made greatly drier, but the subsoil has been unaltered.

Mortality statistics.

The mortality statistics of Morpeth have been independently investigated for this report. The townships of Morpeth and Buller's Green which alone have profited by the sanitary works constitute the area of the inquiry. Correction has been made for deaths of persons in the workhouse belonging to other parishes of the union, and for deaths in the gaol and lunatic asylum. The following is the summary of the tatistical tables:—

Per 10,000 of total Population yearly.	Before (8 years) 1845–52.	During ($3\frac{1}{2}$ years) 1853–6).	After ($8\frac{1}{2}$ years) 1856–64).
	execution of Sanitary Works.		
Deaths from all causes, all ages	262	263	247
All causes, under 1 year -	56	43	$57\frac{1}{2}$
Males - -	29·1	22·6	32·0
Females -	27·0	20·3	25·6
Epidemic diseases:—			
Smallpox (all ages) - -	$4\frac{1}{2}$	2	$1\frac{1}{4}$
Measles „ - -	$5\frac{1}{2}$	2	3
Scarlatina „ - -	13	19	7
„ under 5 - -	8·1	12·3	5·1
„ over 5 - -	4·7	6·6	1·8
Diphtheria (all ages) -	0	$0\frac{2}{3}$	$2\frac{1}{2}$
Whooping-cough „ - -	3	1	$5\frac{1}{2}$
Croup „ - -	$2\frac{1}{4}$	$0\frac{2}{3}$	3
Erysipelas „ - -	$1\frac{1}{4}$	2	$0\frac{1}{3}$
Rheumatic fever „ - -	$0\frac{1}{2}$	2	$1\frac{1}{3}$
Ague „ - -	$0\frac{1}{2}$	0	$0\frac{1}{2}$
Continued fever „ - -	$18\frac{3}{4}$	10	10
„ under 5 - -	5·3	2·6	2·9
„ over 5 - -	13·45	7·0	7·2
Ditto, probably typhoid, excluding an excess in 1847, (all ages.)	$16\frac{1}{2}$	10	10
Diarrhœa (all ages) - -	$8\frac{1}{2}$	$5\frac{1}{2}$	$14\frac{1}{2}$
„ under 5 - -	4·3	2·6	5·3
„ over 5 - -	4·1	3·0	9·2
Cholera (all ages) - -	(in 1849, $14\frac{1}{2}$)	(in 1853, $11\frac{1}{2}$; in 1855, $2\frac{1}{3}$.)	(in 1863, 2; in 1866, 2.)
Dysentery „ - -	1	2	$2\frac{1}{4}$
Phthisis, all ages and both sexes	$30\frac{1}{2}$	$35\frac{1}{2}$	28
Males, 15–55 -	14·6	13·2	8·5
Females 15–55 -	12·6	19·2	14·2
Lung diseases, all ages and both sexes.	$31\frac{2}{3}$	35	$40\frac{3}{4}$
Males, 0–5 -	9·2	6·3	10·6
Females, 0–5 -	4·0	9·2	7·3
Males, 15–55 -	1·7	2·6	1·6
Females, 15–55 -	1·5	2·0	0·5
Brain diseases, all ages and both sexes.	44	46	36
Males, 0–5 -	10·5	5·0	7·2
Females, 0–5 -	12·1	11·9	9·0
Males, 35–55 -	3·2	1·7	4·1
Females, 35–55 -	2·2	1·3	0·8
"Old age," both sexes, total	26	24	16
Males, over 80 -	6·9	7·0	3·3
Females, over 80	10·3	0·3	6·4

The aggregate mortality, then, shows some little reduction. Diseases incidental to infancy are not seen to have been affected by the works. Smallpox, measles, and scarlatina, will be seen to have declined in mortality since the sanitary works; whooping cough has risen. Continued fevers have considerably decreased, even when such an allowance is made as will allow typhoid to be exclusively considered apart from the imported typhus of 1847. Diarrhœa on the other hand has increased both in children and adults. Cholera, which caused a few deaths in 1849, caused a mortality of about the same amount in 1853, and stray cases have occurred since. Phthisis has diminished to a very small extent, entirely among males, for the female mortality from consumption has risen. Lung diseases at the extremes of life have been more fatal, at working ages slightly less fatal. By a diminution in the deaths of children from convulsions and such complaints a slight improvement appears under the head of brain diseases.

ASHBY-DE-LA-ZOUCH.—Population (1861) 3,840.

ASHBY.

Previous sanitary condition.

Mr. Lee's report to the General Board of Health in 1849 furnishes the following account of the state of this town at that date:—

Soil.

" The surface soil is a vegetable mould of a fertile character, and from 1 to 2 feet deep. The subsoil on the north and east is of broken sand and gravel, varying from 6 to 20 feet; on the south and west clay and blue bind of the coal measures. The whole of the district is extremely broken, dislocated, and distorted in faults or slips, varying from 1 foot to 300 feet; but these faults do not materially affect the surface. The great number and great volume of the springs is probably connected with these faults. The contour is very favourable for the discharge of surface water. The Gilwiskaw brook runs to the south through the town at right angles to the principal streets, and is 6–9 feet wide."

Site.

" It would be difficult to conceive a site better adapted by nature to secure the health of its inhabtants, and it would be equally difficult to find a town more entirely destitute of all sanitary arrangements."

Sewerage.

" The drainage and sewerage of the town is most defective; it is infinitely worse than if it had no drains." The brook course was in a foul state, and the brook was kept up by a mill-dam immediately below the town; and " a sluice appears to have been put down about seven years " since for the irrigation of certain meadows, and complaints were made " that when the process of irrigation was going on there, the whole of " the drainage of the town was pent up." At such a time " refuse " stands in the drains for a great distance, and the foul gases are driven " back into the buildings and through the gratings of the streets. " Another consequence of the sluice is that 12 inches of solid refuse

APPENDIX.
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ASHBY.

"requires to be taken out of the brook course every year. The brook "emits in places an intolerable stench, privies being built so as to empty "their nightsoil into it. Fever and diarrhœa are common along its "banks. Some houses near the brook will not let by reason of the stink. "At a little distance from the town the brook was used for irrigation "with great profit to the crops."

"There is no deep drainage in the town. The ordinary depth of the sewers is from 2 to $2\frac{1}{2}$ feet." They were constructed of bricks without lime, or were square and choked half full of deposit, and the brook backed up into them during flood. Owing to defective house drainage, walls of houses were damp and the floors also; cellars, too, sometimes got filled with sewage. On the same account clay and gravel on which the houses stood was completely saturated with moisture.

The most civilized system of conveniences through this town was by cesspools with or without ashpits in conjunction with them; but "in "a majority of those which came under my notice there is neither drain, "cesspool, nor ashpit, and, on inquiry how they were emptied, I was in- "formed that the only means available was to scoop out the soil from "under the seat and carry it away in buckets." In other instances the privies were over the brook.

Water supply. "There is no public supply of water. There are several public wells with very copious streams, but none of them have been made available for the general use of the inhabitants. The Holywell is the most copious of these public springs, its flow never varies throughout the year. The water is very bright but hard, yet is much prized by the inhabitants."

"The only supply of water for many inhabitants is the Calais spring, which rises a few inches above the level of the brook, on the north side of the town. It is closed on three sides and covered as a well for dipping vessels, but its water is frequently polluted in consequence of the foul state of the brook and the accumulations in its bed. Until 10 years ago the Calais spring water was of the best quality possible, but the bottom of the well has been gradually raised and the water has become very foul."

"There are many private wells in the town yielding a scanty and variable supply. Their depth is from 2 to 20 yards. Much of the water from these wells at the lower part of the town is said to be unfit for culinary purposes. Many complaints are made of wells rendered foul from imperfect drains."

Paving. "Some main streets have flagged and bricked footways. The carriage ways are paved with granite." Other streets were paved with pebbles or granite. Some scavenging was done in the principal streets, but "the courtyards are never cleansed or cared for."

Nuisances. No public means existed of getting privies emptied or refuse removed. Men who made a business of emptying such places stored it up in the towns and sold it to the farmers mixed with stable rubbish.

A clergyman deposed that "there are many lodging-houses for tramps "in Ashby in unhealthy localities. The houses and bedding are filthy "and the occupants indecently herded together." There does not appear to have been other overcrowding.

Sanitary works. Public improvement works in Ashby-de-la-Zouch were begun in 1852 and completed in 1854. They consisted of main sewerage, supply of water, a culvert to the brook, and the drainage of private houses carried out on one plan at one time. The only important work that remained to be done after 1854 was the better paving of the town, which has since been gradually done.

Appendix.

No. 2.
On Results of Works, &c. for promoting Public Health, by Dr. Buchanan.

Ashby.

In Ashby a separate system of surface drains, independent of house and soil drainage, was adopted. In its course through the town the brook was culverted and has since received scarcely any impurities. The culverts were for carrying off storm water, too, and pipes from the street gullies were led into them. Since these arrangements have been adopted there is very rarely any flooding, even of cellars, in times of storm.

Sewerage.

The house sewerage of Ashby was taken to an outfall, a quarter of a mile from the town, into the Gilwiskaw brook. The main sewer, a 15-inch pipe, entered a tank, in which the solid matters were separated by subsidence and by filtering through upright screens, while the liquid overflow went on into the brook.

For the soil sewers in the streets earthenware pipes were everywhere used, mostly of six and eight inches only in diameter, blocks of houses and courts draining into them on the combined plan. The drainage penetrated to every house and court in the town, even if there were no water-closet. All entries to the soil drains were trapped, mostly by earthenware syphons. Rain pipes in some cases were led into the soil sewers and left untrapped for ventilation; no other special means of ventilating the sewers was provided. About a hundred of the old privies were exchanged for waterclosets, but probably an equal number of cesspools were left.

Water supply.

The waterworks constructed in 1852–3 took their supply from the Gilwiskaw brook before its entrance into the town, where its water was very pure and good. A subsidiary source is from the Holywell spring whose water is harder, but good, and more independent of season; it is not used unless the brook water is short. Water is raised by a lift pump into filtering beds (downwards through sand and gravel), and thence the purified water is sent into a storage reservoir at some height and to an upper tank raised 60 feet high, from whence it is delivered under sufficient pressure to supply the tops of all the houses in the town. It is furnished to almost all the inhabitants, and very few wells remain in use.

Including the water supplied to railway and malt offices the amount per head per day supplied on the average was 18 gallons. No cisterns were provided for domestic supply, but there is no watercloset without either a cistern or small service box.

Present state.

As to sewerage.

The condition of the town has been very much improved by these works. Firstly, the sewers act well, only one main drain having been stopped since they were laid down, and that through a defect in construction. They are always found clean and free from deposit; they are flushed in the process of washing the courts and also by large hose from the water mains which wash out the trapped inlets frequently. The works at the outfall have also proved satisfactory. A black, rich-looking mould taken from the filtering tanks is bought with avidity by the farmers, and is said to contain 40 per cent. of the ammonia of the sewage. Some nuisance appears to be occasionally produced, however, when the beds are emptied. The brook itself, after receiving liquid sewage, is used for irrigation occasionally, but, though still valuable, it is not so useful now as before the settling beds were made. Waterclosets are in use in Ashby in most houses in the main streets, and in most courts. They consist of pan and syphon, with water supplied by service box, and act fairly well even among dirty people, but frost is a great trouble to the water service; indeed, it appears to have been the inconvenience of frost that has prevented the whole town being supplied with waterclosets; 80 or 100 privies with cesspools still exist, and perhaps receive half the soil of the town. The cesspools are all combined with the ashpit on the "midden" plan, and are all drained into the public sewers. These

privies are not often a great nuisance, many of them being a good distance off houses, but there are still some few courts where foul privies are complained of as a nuisance. It is to be noted, as a very satisfactory circumstance, that people now-a-day complain of things they would have been perfectly well contented with under the old order of things.

As to water.

Of the water supply the delivery is continuous from 6 a.m. to 6 p.m., though contracted to eight hours when the supply is short. Giving night supply, which nearly all ran to waste, was found to make a difference of 30,000 gallons weekly, even with good supervision. By preventing waste from closets, 18 gallons a head per day is sufficient for all requirements of the town.

Again it is observable that since the new water supply people are discontented with the Holywell water, and complain, when it is being supplied, because of the waste of soap. It has 22° of hardness, while the brook water has 13 or 14 only.

Effect of sewerage on soil.

Many springs were tapped in constructing the sewers. The strata are much broken, so that local accumulations of water may occur, and much of the lower parts of the town is on thick, tenacious clay ; yet the whole soil of those clays, as well as the porous " skerries," must be (according to local opinion) much drier than before the drainage. Houses are no longer damp in their lower rooms, and there is said to be nothing like the former amount of fog in the town.

Paving.

The paving of private courts has been done by the owners, and there are not many courts seriously defective in this respect. Dust is removed by private arrangements, and does not accumulate very much. In the case of privies, however, accumulation constantly occurs until the midden is full ; the custom appears to be for farmers to remove it twice a year. No other nuisances of any moment can be reported.

Cleansing.

The cleanliness of cottages has very remarkably improved, not so much through supervision of their interiors, but through the good example set by cleanliness outside; and in decency and morals those who can speak with authority report an equal improvement. Very few houses are occupied by more than one family. Common lodging-houses are well supervised. Byelaws have only lately been prepared to regulate the construction of new houses.

An extract from notes of the present inspection may be given before proceeding to show statistically what effect the foregoing measures may have had on health. " Turk's Head Yard never was without fever, none " now for years since works done. Now paved, was not. Now four " taps of water, formerly one pump in adjoining yard. Cellars dry, " formerly always flooded. Formerly privies and ashpits, now two water- " closets for six houses. Dust collected in a basket in the corner."

Mortality statistics.

For analysis of the death registers a return was prepared by the kindness of the local registrar, showing the mortality that occurred in the board of health district by itself. Of the detailed figures the following is a summary. Here the caution is wanted, that Ashby is a very small place, and one or two deaths a year more or less would, therefore, leave their mark even on these averages.

Deaths, annually, per 10,000 total Population.	Before (7 years 1845–51) execution of Sanitary Works.	During (3 years 1852–4) execution of Sanitary Works.	After (10 years 1855–64.) execution of Sanitary Works.
All causes, both sexes, all ages	216	189	202½
All causes, under 1 year, both sexes.	48	34	31
Males - -	25·0	14·0	18·3
Females - -	23·0	18·7	12·7
Epidemic diseases:—			
Smallpox (all ages) -	1½	—	4⅙
Measles „ - -	—	2⅔	1⅓
Scarlatina „ - -	0¾	10½	8⅓
Diphtheria „ - -	—	—	0½
Whooping-cough „ - -	—	8	2
Croup „ - -	0¾	1¾	2⅓
Erysipelas „ - -	—	0⅚	1½
Rheumatic fever „ - -	0⅓	—	0¼
Ague „ - -	—	—	—
Fevers „ - -	13⅓	12⅓	5¾
„ over 5 only -	12·5	10·5	5·4
Diarrhœa (all ages) - -	4	10½	8⅓
„ under 5 - -	2·3	6·1	2·6
„ over 5 - -	1·6	4·3	5·7*
Cholera (all ages) - -	0⅓	—	—
Dysentery „ - -	0⅓	—	0½
Phthisis, all ages, both sexes -	25½	28⅓	31⅓†
Males, 15–55 -	10·7	11·5	10·9
Females „ -	13·0	12·3	11·7
Lung diseases, all ages, both sexes.	36¾	31	36
Males, 0–5 -	8·4	7·1	10·1
Females „ -	7·3	4·4	6·0
Males, 15–55 -	6·8	3·5	3·4
Females „ -	3·0	—	1·3
Brain diseases, all ages, both sexes.	36½	34½	32
Males, 0–5 -	10·7	8·0	6·5
Females „ -	12·2	8·0	6·3
Males, 35–55 -	3·7	—	1·8
Females „ -	1·6	1·6	0·5

* Increase accounted for by workhouse alone. † Increase only in old men.

Some diminution in the total mortality, and in infantile death rate, has occurred, and this not by the accident of one or two unhealthy or healthy years; for before the public works, only two years out of seven had a gross mortality below 21 per 1,000, whereas since the works only three years out of ten have had a higher mortality than 21, and in two years the deaths have lately been below 17 in the 1,000; yet in this latter period the more contagious diseases prevailed in Ashby to an extent incomparably greater than before the sanitary works. Smallpox, measles, scarlatina, and whooping-cough have all risen from a very small previous amount to a much larger (but still very moderate) fatality. Fevers, however, have decreased in the proportion of 13 to $5\frac{3}{4}$, and instead of being the incessant scourge of the town, there is one recent period of three years in which only one death was registered from fever. Diarrhœa, however, has doubled its fatality, but the whole excess comes from deaths in the workhouse, not in people elsewhere resident in the town.

Consumption, within working ages, has experienced a slight reduction; lung diseases have been stationary; convulsions and brain diseases in young children have been less fatal. These are the main facts of the after-sewerage period as compared with the earlier time.

Recent fever.

In January 1864 fever, which had been absent from the town for two or three years, appeared again, and attacked several score of persons, seven deaths being registered from fever in the year. It was typhoid, and appeared, on the report of a medical man who watched many of the cases, to be attributable "to some impurity in the water of an "adjoining spring, as I find there are several cesspools made in the sub-"stratum, which is of a sandy and porous character, and readily perco-"lated by any fluid, and I believe the water passes through this stratum "before it gets to the spring. At all events it is a remarkable fact that "in all the cases of fever which have come under my observation the "parties have obtained their supply of water from the same source, "whilst there are many houses in the neighbourhood more crowded "and more filthy, but supplied with the tap-water, and in no dwelling "supplied with that water have I seen a case of fever at present."

No. 3.—Report by Dr. Seaton on certain Offensive Trades in Southwark.

I visited on the evening of Friday, August 3rd, all the nuisances complained of in Green Street, Friar Street, Southwark. They are four bone-boilers, two catgut-makers, and a horse-slaughterer.

Long before reaching the street I smelt the horrible effluvium of the bone-boiling. The stench was very sickening.

1. *The bone-boilers* were Trotman at No. 30, Hoare at No. 32, Rae, and Abel. The two latter state they boil from four to six tons of bones a week; the two former much larger quantities, from 12 to 20 or 25 tons.

Each place was scrupulously neat and clean, except Trotman's. Trotman's was very dirty and very untidy: there were heaps of unboiled bones lying about.

The bones are boiled in vats. All the vats had covers, except the single boiler in which Abel carries on his boiling; this was an open boiler. Boiling was going on at all the places. At Hoare's (a model place in construction, as well as in cleanliness) and at Rae's the lids were down, and all the reek of the vats was passing into the chimney or shaft. Hoare has a smoke-consuming apparatus attached to his furnace, and states that all the reek of the vats is passed through this. At Trotman's, where three vats were at work, the lids were all up; and though I was informed that this was only because the materials (which were then boiling) had but lately been put in, and that the boilers would be closed immediately, on returning in half an hour's time I found them just as before; the reek from the boilers when closed goes directly into the chimney or shaft of the furnace, but there is no smoke-consuming apparatus.

At all the establishments, in fact, but Hoare's, the reek passed, direct and unchanged, either into the air of the boiling room (as at Abel's), or into the chimney or shaft (as at Rae's and Trotman's when the lids of the boilers were down). None of the shafts, so far as I could judge, was higher than an ordinary three-storied or four-storied house. Experiment would be necessary to determine whether the apparatus as fixed at Hoare's does really destroy the effluvium of the bone-boiling; if so, it seems reasonable that the other establishments should be compelled to employ similar apparatus. Unless the effluvium can be wholly got rid of in this way, the reek ought to be carried much higher into the atmosphere than is done by the present shafts.

After the bones are boiled they are stored in large storerooms, in which 40 or 50 tons accumulate before they are removed. They send out a sickening smell. The bone-boilers all say that the accumulation —which, according to the amount of business done, may take place in a fortnight or three weeks, or may require five or six weeks—is necessary because the shippers won't remove anything but a complete cargo. I found, however, that at the horse-slaughterer's (on whose premises a certain amount of bone-boiling is carried on) removal of the bones is effected when the amount accumulated reaches five or six tons. I think that such large accumulations as take place at the bone-boiling establishments should be prohibited, the bones should be frequently removed (two or three times a week), the store rooms should be well closed, and ventilated into the shafts.

The bones are removed in open vans, or vans covered with tarpaulin. I met some uncovered vans full of bones going from one of the yards.

2. *The catgut-makers.*—These are Potier and Curtis. The premises of both were clean, Potier's remarkably so; Potier's were as little offensive as in such a business can be possible; but at Curtis', where a

Appendix.

No. 3.
On certain Offensive Trades in Southwark, by Dr. Seaton.

much larger business is carried on, there was an abominable stink. The quantity of stuff worked in at this place is estimated to vary from 30 to 90 tubs a week, each tub containing somewhere about a hundred-weight of guts.

3. *The horse-slaughterer's.*—At this place 70 or 80 horses a week are slaughtered; the hides, &c., are removed daily. The boiling the flesh and bones goes on on the premises. The premises were admirably clean, and the boilers are fitted with proper covers, but there is no consuming apparatus.

When a number of stinking nuisances are close together in a street, it is difficult sometimes to determine from which a particular smell arises. It seemed to me that *in* the street I smelt most the horse slaughterer's; but the air of the whole surrounding neighbourhood is contaminated by the bone-boiling effluvium.

Green Street is situate in the midst of one of the densest populations in London; and in it and the immediately surrounding streets there are so many causes of disease in the overcrowding of population, the poverty of the inhabitants, the defective supply of water, and abundance of filth, that no analysis I might be able to make of the death-returns would be of any value to show the particular effect on health of the nuisances now reported on, as apart from other disease-producing causes. The disgust and annoyance the effluvia must cause to those compelled to live near them must be extreme. If the occupations which cause these effluvia cannot be removed to other and more suitable places, it appears to me that some of the processes might be made less offensive by adoption of the means I have suggested. In communication with the chairman of the Sanitary Committee of the district he laid stress on three things as, in his opinion, especially requisite: (1) the deodorizing, chemically or otherwise, all vapours from the bone-boiling in their passage through the shafts, (2) the frequent removal of all refuse, (3) the removal of refuse in properly-constructed closed carts.

No. 4.
Extracts from Reports relating to Outbreaks, &c. of Fever.

No. 4.—Extracts from Reports relating to Outbreaks or Persistencies of Fever.

a. By Dr. Buchanan on Typhoid Fever at Buglawton.

a. On Typhoid Fever at Buglawton.

I have to report that I went, in pursuance of instructions, on April 17 to Buglawton, and that with the assistance of the clergy, medical men, and others of the neighbourhood, I continued my inquiry over three days, and I now beg to present the results thereof.

Population.

The village of Buglawton, of which a rough map accompanies this report, is a suburb of the town of Congleton. Buglawton township comprises a large agricultural area besides this village, and the total population is 2,000 to 2,100. The village has about half of this number, and if to it be added the row of houses called Eaton bank, which are more intimately connected by position with Buglawton than with their own township of Eaton, the population of the district which this report has to deal with may be taken at about 1,150.

Government.

The local government of Buglawton for sanitary purposes is in the hands of a Local Board of Health who has been constituted two years, but who have done no work worth mentioning except the construction of one sewer. They employ an inspector of nuisances, but there is scarcely an evidence of his work to be discovered.

Occupations.

The industries of Buglawton are in the main silk-throwing and spinning. There are four silk mills, only two of which have recently been

at full work. A mill for powdering calcined bones for use in the potteries affords employment to a few hands. For some years the trade of Buglawton has been much depressed; wages are low and a good many people getting no regular employment have left the village, so that there are numerous houses vacant.

The habits of the people are, as a rule, cleanly, and most of the cottages are tenanted by single families. There is no general overcrowding, but in particular cases a single room may be occupied at night by an undue number of persons of one family, or exceptionally by a family who receive one or more of the mill hands to lodge with them.

Lodgment of people.

Mills.

The silk mills are mostly old buildings, not constructed with particular reference to space and ventilation, yet not obviously (at the time of inspection) defective in these respects. No effluvia or smell, such as arises from crowding of people, was perceived in them. The air of many of the rooms was hot and damp—a condition that appears needful to carrying on the manufacturing operations.

Sewerage and privies.

The only drainage of Buglawton is by superficial sewers of stone or pipe which receive the rainfall, the slops of houses, and in some cases the liquid matters from middens. Foul smells from the sewers come up the street gullies, which are mostly if not always untrapped. The only waterclosets are in a few houses abutting on the river, and these are kept clean by throwing water down them from a bucket, and their outlet did not appear to be always pervious. The common kind of convenience is the midden where ashes and the dry refuse of the houses is thrown upon the contents of the privy pit. Many of these were found undrained and stinking. The privies are often in too close neighbourhood to the houses, but this is by no means a universal fault.

Paving.

The paving of the village is in the main good, but in parts is of a kind that is difficult to keep clean by sweeping. Most private courts have channels, sometimes of good smooth bricks, sometimes of uneven pebble stones.

Water supply.

There is no public water supply in Buglawton. The river Dane receives the whole sewage of many houses, and the liquid sewage of a great many more, yet from this river at points adjacent or immediately below the discharge of sewage into it, most families get water for their domestic purposes. The Dane water is, however, seldom used for drinking, except by some persons in Dane Row abutting on the river, and they filter it before using. Drinking water is procured from several sources as shown on the map and explanation to it. The chief of these are in private hands, a charge of 1*d.* per week per house being made for the use of them. One belongs to Mr. Scraggs, and is sunk about 15 feet into gravel. It was suggested that this well might get contaminated by the churchyard which stands on high ground above it, but no importance attaches to this notion because (1.) the churchyard is about one-third of a mile off and (2.) the water-bearing gravel does not extend up the hill on which the churchyard is situate, while the hill is formed of marls comparatively impervious. A more possible source of contamination to this well would be the channels or privies adjacent The privies are some 30 paces off and the channels appear as watertight as good bricks and workmanship can make them. But Professor Miller's analysis leaves no doubt that considerable organic contamination of this water does occur, and is present even when the fever has abated. The other chief source of water is from the hills on the Congleton side of the river which is received into a tank near Mr. Hogg's mill, and then is brought across the stream into his yard. There appears no likelihood of this water being contaminated by organic matters. The following is the account of each of these waters given by Professor Miller:—

APPENDIX.

No. 4. *Extracts from Reports relating to Outbreaks, &c. of Fever.*

a. On Typhoid Fever at Buglawton.

Analyses.

" *Buglawton Waters.*

I send you now the results of my examination of the two samples of water labelled respectively—

(1.) " Hogg's water, Buglawton, April 20, 1866," on a printed label.

(2.) On a similar printed label " From Scragg's well, Buglawton, April 20th, 1866."

Both waters are clear, colourless, and bright, without any marked odour or taste.

No. 1 is not a bad water. It is rather hard, but softens sensibly in boiling. It contains but little ammonia or nitrates, and a moderate amount of saline matter, consisting chiefly of carbonates and sulphates of lime and magnesia. It is well aërated, and contains scarcely any organic matter.

No. 2 contains more than twice the amount of salts present in the first sample. It is much harder, and softens but little on boiling. The quantity of organic matter is rather large. It contains a notable amount both of nitric acid and of ammonia. It is badly aërated, and is altogether an objectionable water for dietetic purposes. It contains chiefly sulphates and chlorides of lime and magnesia, with a small proportion of the salts of the alkalies.

I subjoin the details of the analyses :—

	Hogg's.	Scragg's.
Hardness on Clark's scale - - - -	17°·2	26°·5
Do. do. after boiling one hour - -	10°·3	23°·1
Specific gravity - - - -	1000·24	1000·44
Total solids in grains per gallon - -	19·65	42·95
Consisting of { Fixed salts - - - -	19·50	39·65
Consisting of { Volatile and combustible matter -	0·15	3·30
Nitric acid - - - - -	0·82	5·84
Ammonia - - - - -	0·01	0·12
Total gas per gallon in cubic inches - -	9·7	12·9
Carbonic acid - - - -	2·84	5·74
Consisting of { Oxygen - - - -	2·10	0·42
Consisting of { Nitrogen - - - -	4·76	6·74
Ratio of oxygen to nitrogen - - -	1 : 2·26	1 : 16

Other waters are of similar source, and probably of similar character to these two.

Nuisances.

Nuisances about houses are commonly to be observed. Heaps of ashes and vegetable refuse, stinking open channels and stagnant pools are of frequent occurrence. Pigs were often kept near houses in ill-constructed stie, but most of them have lately been removed by order of the local board.

Fever in Buglawton.

Sporadic cases of typhoid fever are not infrequent in Buglawton, in Congleton, and in most neighbouring villages, and within the past six months 150 cases of typhoid fever have occurred in the village of Buglawton with Eaton Bank. The disease appears to have been of severe type, having a very long duration and a considerable tendency to relapse. Diarrhœa was an almost constant, and hæmorrhage from the bowels a not unfrequent symptom. The mortality amounted to 12, or, including two persons who died in Congleton after contracting the fever at Buglawton, to 14.* Fourteen gives a death-rate of 9 per cent., which is about the usual rate of mortality in similar outbreaks.

Cases and deaths.

Age.

Young persons were the chief sufferers from the fever. Of the fatal cases only two were over 25. Only three of the fourteen were males.

* One or two other persons who have died lately were also the subjects of the fever, but died from complaints that they had previously laboured under, their deaths not appearing to have been accelerated by the fever.

Distribution.

The disease was not distributed evenly through the village. Its maximum attacks fell on the northern lower-lying end of Havannah Street. It occurred with less, but still with very great intensity in the remaining parts of Havannah Street and Dane Row, while in other streets of the village and in the detached portion situate on the high ground near the church, although there were numerous attacks, they were in fewer houses and of fewer people in a house.

Referring to the map for the localities named, the following table gives the attacks in each part of the town:—

Locality.	No. of Houses.	No. of Houses attacked.	No. of Attacks.	No. of Deaths.
Eaton Bank - - - -	30	6	12	1
Havannah St.:—Albert Row -	10	6	22	1
" other houses on east side -	5	2	6	1
" houses on river side of street, north of Johnson's mill -	19	11	28	1
" do., south of do. -	22	10	20	2
Flint Mill Cottages - - -	3	1	3	—
Dane Row - - - -	say 12	6	8	—
Mill Street, north side - -	18	3	3	—
" south " - -	10	2	3	—
Queen Street, north side - -	17	4	5	1
" south " - -	17	4	12	1
King Street, north side - -	10	2	2	1
" south " - -	15	3	3	—
Paradise Row - - -	10	—	—	—
Buxton Row - - -	13	1	1	—
Barracks - - - -	8	1	1	—
Church Bank and Harding's Bank, all houses there - -	50	13	18	2
Totals - - -	269	75	150	12
Country parts of township - -	?	4	6	1
Removed from Buglawton, after contracting fever there - -	—	?	?	2

Occupation.

Respecting the occupation of persons attacked by the fever the statement has been made that they were mostly those employed in Mr. Johnson's mill, but on careful inquiry it appears that the first case of fever was in a girl who did not work there; that in many instances of multiple attacks in one house, the first attack was not in a mill hand at all; and generally that any apparent proclivity of the fever to attack Mr. Johnson's workers has arisen only from their residing more numerously near the mill where they were employed, and which happened to be the part most affected by the fever.

Origin and course.

The first case of typhoid was in the person of a young woman living in one of the middle houses of Albert Row. She had not been away from home or exposed to any known source of infection. She was taken ill about 19th November last, and recovered after several weeks' illness. The next case occurred about a week later in the same month, and in a quite different part of the village, up at Harding's Bank, near the church. The third case began about December 5th in a cottage of Havannah Street nearly opposite Albert Row. Next, about December 20th, a person in the next house to the last mentioned was attacked, and

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No. 4.
Extracts from Reports relating to Outbreaks, &c. of Fever.

a. On Typhoid Fever at Buglawton.

the disease spread through the family. And about the same date another girl fell ill at Harding's Bank in the row of houses opposite to that where the former case occurred. At the beginning of January numbers of people were attacked in Albert Row and on the opposite side of Havannah Street, and the disease then became pretty general over the village. At one time there were nearly 100 persons ill of fever together. At the time of inspection, no fresh case had occurred for three weeks, and only one patient was seen who had the eruption of typhoid on the skin.

Causation.

The facts ascertained as to distribution and sequence of cases do not appear to show that the whole outbreak followed from a single first case as a centre, but the circumstance that the end of Havannah Street where the first case did occur was most severely affected throughout the epidemic, and that a number of attacks occurred close together (as to time and place) about six weeks from that first case and a month from the second case in that locality, appears to point to the existence of some special cause of fever in this neighbourhood; the low situation of this end of Havannah Street deserves to be mentioned, but this lowness was not such as to interfere with natural drainage. The impurity of the water of Mr. Scraggs' well is a more important consideration; though bright and pleasant to the taste it is evidently habitually contaminated by drainage; part of which appears in it as chlorides, nitrates, and ammonia, while part remains in an unoxydized condition. It is probable that the consumption of this impure water acted as a predisposing cause of the fever, and some of the facts above given may be held to point to specific contamination of this water by typhoid poison derived from the first patient in the house adjacent to the well.

It is, however, to be remembered that other parts of the village and people who never drank Scraggs' water were also attacked, though not with the same frequency as the north end of Havannah Street, still in considerable numbers. Conversely too, it is to be stated, though no importance can be attached to that fact, that many drinkers of Scragg's water escaped the fever altogether.

Sanitary action and medical relief.

It has been stated that the Board of Health of Buglawton has done very little sanitary work, and the existence of the fever does not appear to have troubled them much. Their last meeting before the present inspection had been held in January, when the step of removing pigs from the neighbourhood of houses was the thing resolved on. The sanitary inspector has been no more active than usual. When the fever began to show an epidemic prevalence, a committee of gentlemen, headed by the Rev. H. R. Bramwell and the Rev. H. Sherlock, the incumbent and curate of Buglawton, was organized for the relief of the sick poor; they obtained the services of two "nursing sisters" from St. Margaret's House at East Grinstead, who rendered most valuable assistance; they gave coal, beef-tea, and (under medical direction) stimulants to the sick, and food and clothing to convalescents, and they employed people to wash and disinfect bedding and cottages. 120*l.* was collected and spent on these objects. And the two clergymen acting for this committee directed the attention of the Secretary of State to the outbreak, and requested that an examination of its causes should be made by a Government Inspector.

Advice to authorities

On April 19th, at a meeting of the Local Board of Health specially summoned, I made a statement of the foregoing facts, so far as they were then ascertained, and urged upon the Board the necessity of improving their drainage and water supply and of engaging a competent engineer to advise them as to the best methods of doing so. I also pointed out the importance of strict and constant attention being paid to the removal of nuisances. Since my return to London I have written to the Board an abstract of the statement and advice I tendered to them.

Hearing that cases of fever had occurred somewhat numerously (though apparently unconnected with the Buglawton outbreak) at a village named Biddulph in the Congleton Union, I have addressed a letter to the Board of Guardians, as the authority for executing the Nuisances Removal Acts.

b. By Dr. SEATON on TYPHOID FEVER at TOTTENHAM.

Page Green is a detached hamlet in the parish of Tottenham, situate near the river Lea, within a very short distance of the spot where the sewage of Hornsey, as well as of that of Tottenham, has its outfall into the river, and of the sewage works belonging to the Tottenham Local Board of Health. It is a place which has for the most part grown up within the last seven years, and many of the houses are of quite recent construction, some not having been inhabited above a few months. The houses are now between 80 and 90 in number, all (except a block of two houses near the railway) being aggregated in two streets called Markfield Road and Stamford Road, and a terrace joining these two roads at their northern end.

In this hamlet typhoid fever and diarrhœa have prevailed for the last two years and more to a remarkable extent, but with very little fatality. The existence of fever, however, in the locality has not by any means been limited to this period: for in 1862 (beyond which time I did not think it necessary to carry back my inquiries) many cases had occurred, and two of them had been fatal.* But the particular outbreak which has excited so much attention and led to this inquiry seems to have begun about June 1864, to have become greatly extended by Christmas of that year and the spring of 1865, and to have continued to the present time. There have been several recent cases.

During the period of this outbreak many of the houses have changed occupants; and on this account, as also because many of the inhabitants take lodgers, I have found it impossible to ascertain exactly the total number of cases. But from information for which I am indebted to Dr. May, Dr. Pool, Mr. Hall, and Mr. Wolstenholme, surgeons, of Tottenham, as well as from my personal inquiries at 56 of the houses,† I ascertained that there had been a case or cases of fever in 30, or (excluding one house in which the nature of the illness appeared open to some doubt) in 29. Nearly 60 cases of typhoid fever were vouched by medical testimony; and if I add some cases which must from the description have undoubtedly been typhoid, but which were not attended by the local medical practitioners, and cases of persistent diarrhœa occurring in the same houses and at the same time with the typhoid, I am satisfied that the number of cases of illness which in this small hamlet have in these two years resulted from morbific local influence has not been short of 100.

The mortality from the fever has, however, as I have already stated, been very small, and this would be accounted for by the great majority of the cases having been in young children. The following are all the entries of deaths from fever in this locality which I find in the "Register of Deaths" for the sub-district:—

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* Extract from the "Register of Deaths" for Tottenham sub-district:—
Oct. 31, 1862, at Markfield Road, F. æt. 35, "continued fever."
Dec. 31, 1862, at Markfield Road, F. æt. 43, "gastric fever."

† These comprised *every* house in which I had any reason to believe any case of fever had occurred, except two houses the occupants of which had gone away: in each of these two houses there had been a single case, information concerning which was kindly given me by Dr. Pool.

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b. On Typhoid Fever at Tottenham.

June 30, 1864, at Stamford Road, f. æt. 11, "typhoid fever."
December 31, 1864, at Markfield Road, f. æt. 32, "enteric fever."
January 31, 1865, at Markfield Road, m. æt. 23, "typhus."
November 30, 1865, at Markfield Road, f. æt. 21, "typhus,"*

This continued prevalence of typhoid directed my inquiry, as a matter of course, in the first instance to the sources of supply of drinking water. Many of the houses at Page Green derive this supply from surface wells, others are supplied from the waterworks of the Local Board of Health; none of the 56 houses at which I made inquiry had on the premises a supply from both sources. Inquiry as to the effect this difference in the source of water supply had had on the incidence of the fever gave the following results:—

Source of Water Supply.	Number of houses visited.	Number of these houses in which *a case or cases* of fever had occurred.	Number of these houses in which *more than a single* case of fever had occurred.	Number of these houses in which *there had been a succession* of cases of fever or diarrhœa.	*Approximate* total number of cases of fever, including persistent diarrhœa.
Surface wells - -	24	19	17	13	80
Local Board - -	34†	10†	4	2	22
Totals - -	58	29	21	15	102

The difference was so striking‡ as to lead at once to the further inquiry whether, in the houses supplied by the Local Board in which fever had prevailed, the inhabitants had really taken all their drinking water from the board's supply, or whether they might not have derived at least some share of it from their neighbours' surface wells. I found that the occupants of six of these houses—*including all the four which had had more than a single case of fever*—from dislike of the board's water, or from the irregularity with which they were supplied, very frequently borrowed water from their neighbours' wells;§ at three of the houses, from removal of the families in which the fever case had occurred, I could get no information on this point; at the remaining house, in which there had been last autumn a case of mild typhoid in a child, the water drunk was, so far as could be ascertained, exclusively that of the Local Board. Excepting these last four cases (concerning three of which no

* In this case, Mr. Hall informs me, the fever, which was not typhoid but real *typhus*, was not of local origin. It was contracted in Lancashire, whence the girl was sent home ill.

† Two houses are included, referred to in a former note, which I did not visit as the occupants had gone away, but in each of which there had been a case of fever.

‡ It would have been still greater if time had permitted me to visit the remainder of the houses (about 30), all of which I had reason to believe had been free from fever, and nearly, but not quite, all of which were supplied with water by the Local Board.

§ The water supplied by the Local Board of Health was complained of by several of the inhabitants as being hard, turbid, and red. The turbidity and redness were only noticed when the water first came on, the supply, though professedly constant, being really intermittent, and were no doubt due to rust in the pipes; but considerable hardness, as analysis by Prof. Miller showed, existed even after boiling. The irregularity and uncertainty of supply were universally complained of, and the truth of the complaint was admitted by the Local Board, who, however, had taken steps to increase their resources.

information on the subject could be got), it is established that in every case of fever which has occurred at Page Green the supply of drinking water had been wholly or in part, and in the immense majority of cases wholly, from the surface wells.

These wells are very shallow, about seven or eight feet deep, sunk in porous gravel. The water they yield is said to be generally bright and pleasant, and is evidently a favourite water with the people. Some selected for analysis from a well in a row of houses called Caines Terrace, in which fever had particularly prevailed, was very popular; and the inhabitants, though allowing it was not *always* so good and pleasant as at the present time, seemed surprised at the notion of their being anything injurious in it, and amused at its being analysed. But the liability of these wells to surface and sewage contamination had been manifested in some of the houses on various occasions, by the water becoming unpleasant to taste and smell after heavy rains or from matters thrown down sinks; and it was well illustrated, at the time of this inquiry, at a house in the Markfield Road, where some carbolic acid, which had been thrown down the yard-sink, was distinctly smelt in water pumped from the well in my presence. It should be stated that the houses at Page Green (except three) have not cesspools, but water-closets communicating with the sewers of the Local Board; but in those houses which derive their water supply from wells there are no means of flushing except by pails of water poured down occasionally.

Specimens of water from the wells at No. 1 Cambrian Cottages in the Markfield Road, and at No. 5 Caines Terrace in the Stamford Road, were submitted to Professor Miller for analysis, and both of them unreservedly condemned by him. Of the first he reports, "It is "somewhat turbid, hard, and contains a very unusual proportion of "ammonia, as well as a notable amount of organic matter. Some "sewer drainage most probably finds access to this well. It is quite "unfit for use for dietetic purposes." Of the latter he says, "It is a "very hard water, and it continues so after boiling. It contains "nitrates and a considerable amount of organic matter. Its aeration is "very defective. I should recommend its immediate discontinuance as "a beverage."

The way in which people go on unconsciously imbibing fever and diarrhœa from such wells as these is so aptly illustrated by the occurrences at Caines Terrace, that I must be permitted to give in brief detail the results of my inquiry at the five houses of which the terrace consists, all deriving their water from two or three surface wells. In the one (No. 5) from which the water was taken for analysis, Mr. Gaffney has lived for three years; his family, consisting of four, had all diarrhœa soon after they came, and in Nov. 1864—Jan. 1865 the son and daughter had marked and severe typhoid; the son narrowly escaped dying of it; they were attended by Dr. May. In the next house (No. 4), supplied by the same well as Gaffney's, in Dec. 1864 Mrs. Greenwood, the then occupant, was attacked with typhoid, and was attended by Dr. Pool; in May 1865 the present occupant, Mrs. Slark, came; she, her son, and her daughter (the only permanent inmates), had diarrhœa immediately upon their coming; the lodgers whom she receives have, each as they came, successively had diarrhœa, and some of them have had also low fever. Mrs. Barnes has lived in the next house (No. 3) for two years; they are four in family, and for the first six months of their residence they had nothing but fever and diarrhœa; lately they have begun to take lodgers, they have had two sets, and each set has had diarrhœa. The two remaining houses are occupied by families who have only resided for seven weeks,

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but in each of these houses there was fever last year. Of the present occupants, the family residing in one of them, five in number, have all suffered from diarrhœa since they came; the family residing in the other, three in number, have not suffered in any way, *but this family boil first all the water which they use for drinking.* Mrs. Slark informed me that many of the neighbours who were supplied by the Local Board came begging water from her well. And I found that the occupants of two houses so supplied close by—the only two houses supplied by the Local Board in which there had been *succession of cases* of fever and diarrhœa, viz. Graham's and Bartholomew's—had very frequently borrowed water from this well.

The story of Caines Terrace is repeated in a row of three houses in the Markfield Road supplied by one well, in all which houses typhoid fever had prevailed at the end of 1864 and early part of 1865, and in two of which very nearly, if not quite, all the occupants (12 in number) had had that disease, one of them dying of it; in other houses in the Markfield Road; and in both the houses standing together near the railway. In one of these latter not only have there been four cases of fever in the family, who have now and for the last $2\frac{1}{2}$ years been in occupation, but other cases of fever had been attended by Dr. Pool before their occupancy.

Upon the grounds I have stated, the conclusion appears to me irresistible that the fever and illness at Page Green have been mainly kept up by the use of impure surface water for drinking, and I deem it a matter of the most urgent necessity that the surface wells should at once be closed.

c. On Typhus at Warrington.

c. By Dr. Buchanan on Typhus at Warrington.

1. The fever is typhus, and is of contagious nature. The conditions under which this fever habitually spreads are dirt, poverty, and overcrowding.

Fever in Warrington.

2. Some 200 cases of this fever have occurred in Warrington in the past three months. It has obviously spread, in the majority of cases, by direct communication with sick or convalescent persons. In a remarkable instance, about half the persons employed in a workshop were attacked, the disease spreading from worker to worker according to their places in the shop, and being diffused by them about the neighbourhood. Whole families have been attacked, the fever having been brought into the house by one member, and only ceasing when all susceptible persons had succumbed to it. The localities and houses attacked have been among the poorest and most crowded in the town.

3. Except for this fever, it does not appear that Warrington is at present experiencing any remarkable mortality. But in quite recent periods, epidemics of measles and scarlatina have occurred with a fatality that points to defects in the sanitary circumstances of the people, particularly in regard of their manner of lodgment.

Action required.

4. It follows from what has preceded, that the measures required for arresting the progress of typhus and for putting the town in a condition to resist the ravages of contagious epidemics are twofold:

(*a.*) Provision is required for the immediate isolation and treatment of cases of contagious disease that occur in poor houses, where there is no means of properly separating the sick persons from the healthy inmates of the houses.

(*b.*) Measures must be taken to prevent the overcrowding of people in the poor houses of the town.

5. The Sanitary Act of 1866 gives powers to the Local Board to direct the removal of persons affected with dangerous contagious disease,

whether paupers or not, who are without "proper lodging and accommodation," or who live in rooms occupied by more than one family, to hospital. Assuming that the wooden hospital at the top of St. John Street can be made available for the reception of fever cases, it is desirable that this power should be extensively used. Power is also given by the same Act to reduce the overcrowding in houses, whether common lodging-houses or not, and whether occupied by members of one family or of more than one family. It is important that this provision should be efficiently carried out.

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On Typhus at Warrington.

6. When fever breaks out in any house, the provisions of the Act relating to disinfection of rooms and clothes should be thoroughly carried into effect.

7. It will be necessary that all this action should be carried out under a medical superintendent, who, for this purpose, should be the medical officer of health. This officer should be required, in the first instance, to give a considerable portion of his time to carrying out the functions that have here been indicated.

8. With a view to preventing the recurrence of the devastating epidemics that have so frequently affected the town, it will be necessary that the action of the local board should be continued beyond the present outbreak, and should be directed especially to improving the lodgment of the poorer classes, and to putting into wholesome condition the conveniences attached to their houses. The 35th section of the Sanitary Act, especially, gives powers to the local board that are much needed in Warrington.

No. 5.—DIRECTIONS and REGULATIONS issued in 1866, in relation to ASIATIC CHOLERA, by the LORDS of the COUNCIL, acting under the DISEASES PREVENTION ACT, and OFFICIAL MEMORANDA circulated in connection therewith.

No. 5.
Directions, &c. relative to Asiatic Cholera.

a. DIRECTIONS and REGULATIONS of July 20th, 1866, for Places not within the Metropolis.

a. For places not within the Metropolis.

I.—*Preliminary.*

Preliminary arrangements.

Forthwith on the issuing of the present regulations, the Clerk of every Board of Guardians shall summon a special meeting of the Board, in order that the present regulations may be brought before them, and that the Board may make (as they are hereby required to do) such preliminary arrangements as will enable them, if sudden need shall arise, to carry the following regulations into immediate effect; and the Board at such meeting shall direct the Clerk, by instructions to the Medical Officers, and by circular letters of request addressed to all legally qualified Medical Practitioners in the union or parish, and in such other ways as the Board may think necessary, to take measures for causing the Board to be made acquainted with any presence of Cholera or unusual amount or severity of Diarrhœa in the union or parish, or any part of it, if such be existing or should thereafter exist; and the Board, if apprised of any such presence of Cholera or Diarrhœa, shall thereupon forthwith, so far as the circumstances require, do the several things herein-after ordered:

II.—*When Cholera is in an Union or Parish.*

Meetings of the local authority.

1. Every Board shall make arrangements for meeting, in districts where the disease is actually prevailing, daily, either in a body or in one or more committees, according to the exigencies of the district, for the purpose of exercising the powers conferred upon them by the Act.

Place of meeting.

2. The meetings may be held at the ordinary Board-room, and, where

necessary, at such other places as shall appear to be most convenient for dealing with the disease, and the Board shall cause proper minutes of all proceedings to be made and duly recorded.

Appointment of Medical Adviser.

3. Where the Union or Parish forms part of any town of more than 60,000 inhabitants, or contains a town of more than 40,000 inhabitants, according to the report upon the last Census, or where several parts of the Union or Parish are at one time suffering from Cholera, the Board shall appoint some legally qualified Medical Practitioner, to attend at the meetings and render his advice thereat, and superintend all the medical arrangements for preventing and treating the disease.

Appointment of Medical Visitors.

4. In each district in which Cholera is present, or, if the quantity of work to be done renders it desirable to subdivide the district, then in each of such subdivisions a legally qualified Medical Practitioner shall be put in charge of the district or subdivision for the medical purposes of these regulations ; and to each such Medical Practitioner shall be allotted all needful Medical Assistants and such other Assistants as the Board see fit.

Such District Medical Practitioner, or one of his Assistants, shall at least once daily visit those parts of the district which are inhabited by the poorer classes and wherein the disease is, and shall there inquire at every house as to the existence of Diarrhœa or Cholera, and shall enter in a book to be kept for the purpose the facts as to all cases he may meet with, and shall without delay give, or take the proper steps for causing to be given, all necessary medical assistance to the sick. And the Medical Practitioner or Assistant shall, when visiting the part assigned to him, be provided with medicines for immediate administration in urgent cases, and shall be held to be in medical charge of all cases of Diarrhœa or Cholera with which he may meet until he is relieved by such other provision for their medical attendance as may be made or sanctioned by the Board.

Their report.

5. Such Medical Practitioner shall, by transmitting his above-required book, or otherwise, report daily to the Board of Guardians, or to the Committee of the district for which he acts, the result of his own and his Assistants' inquiries, and shall make such suggestions as to the state of the district as he shall deem advisable.

Board to report nuisances.

6. In places where the Board of Guardians are not the Nuisance Removal Authority, the Board shall, without delay, cause report to be made to such authority, and, if the Board see fit, shall complain to the Justices, of every case where any Committee, Medical Practitioner, or Assistant, employed by the Board, shall find any nuisance injurious to health existing in any premises visited by them.

Visitors to report cases of destitution to the Relieving Officer.

7. The visitors shall, where they find it expedient, communicate to the Relieving Officer of the district any case of destitution requiring relief, which is not entered in his relief list, and such officer shall forthwith visit the same and give such relief as in his judgment the case shall require.

Board to provide dispensary stations.

8. The Board shall provide a sufficient number of dispensaries, to be open night and day, at convenient places within their district, with an adequate supply of such medicines, medical appliances, and disinfectants, as their Medical Adviser shall recommend, and with a legally qualified Medical Practitioner or skilled Assistant always in attendance at each ; and such medicines, medical appliances, and disinfectants, shall be dispensed without charge by such Medical Practitioner or Assistant to persons bringing orders for the same from the District Medical Practitioners, and to other persons who apply for immediate medical treatment. And the names and addresses of all such applicants shall be sent to the District Medical Practitioner of the place in which they reside.

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9. In every case of Cholera or Diarrhœa, where the patient is not under medical care and treatment, the Board shall cause medical assistance to be rendered with the utmost expedition, and such aid, and comfort, nourishment, and accommodation, as the circumstances of the case will admit, with the object of restoring health.

Board to supply medical aid to poor Cholera Patients.

10. The Board shall provide competent nurses to aid every District Medical Practitioner in his attendance upon the patients suffering from the disease.

To provide nurses.

11. When the Medical Adviser recommends, the Board shall, with as much despatch as practicable, provide fit and proper accommodation for the reception of such patients as have no home, or cannot properly be treated at home, and may with advantage to themselves be removed, and shall cause the same to be provided with all appliances, medicines, furniture, and other things necessary for the emergency, and shall appoint a legally qualified Medical Practitioner, with or without Assistant, as the case may require, to attend to the same.

To provide hospitals in certain cases.

12. If Cholera or Choleraic Diarrhœa exist in any dwelling whereof the Medical Practitioner reports that the sick and healthy cannot therein be properly separated, the Board shall forthwith cause adequate accommodation to be procured for the reception of the healthy; and, when the Medical Practitioner recommends that the sick person shall not be removed, but that the healthy shall be removed from the same room in which the sick person is lying, the Board shall cause the other inmates of such room to be removed to some convenient place of reception.

To provide for the separation of the sick from the healthy in the same dwelling.

13. The Board shall, in dwellings where Cholera or Diarrhœa exists, cause proper disinfectants to be used in sufficient quantities for the purpose of disinfecting the discharges from the sick, and the bedding, clothing, and other things thereby infected, and the utensils and privies in which such discharges may have been received.

To provide disinfectants and to cause things and places to be disinfected.

14. The Board shall cause every article of clothing, bedding, or furniture which shall have been infected with any such discharge, and which they shall find incapable of being speedily disinfected, to be forthwith destroyed, the Board within a reasonable time replacing all such articles, or paying the reasonable value to the owner.

To cause infected goods to be destroyed.

15. If it be shown to the Board that any drinking-water used in their district is polluted, they shall take measures, with as much expedition as possible, for procuring wholesome water to be supplied in its stead, so far as the case requires, to the inmates of the houses in their district, and for preventing, as far as possible, the further use of the polluted water. And every Board owning or having possession of any waterworks for the supply of water shall cause the reservoirs, cisterns, pipes, pumps, and other apparatus belonging thereto, to be carefully examined, cleansed, and purified, and other necessary measures to be taken so that the water may be supplied without impurity.

To procure good water in place of that which is polluted.

16. The Board shall make due arrangements with undertakers and with the proper authorities of the churchyards, burial grounds, and cemeteries of their district, so that coffins may be ready to be supplied immediately on demand and interments speedily taken place in the cases of deaths arising from Cholera or Diarrhœa, and the Board shall, when informed of any such death, cause the corpse to be buried with the earliest possible despatch.

Provision for burials.

17. Where any death shall occur from Cholera or Choleraic Diarrhœa, no collection of persons shall assemble in the room where the corpse is, and no waking of the dead shall be allowed.

Assemblage of persons at waking the dead prohibited.

18. The Board shall cause the immediate removal, from any room which living persons inhabit, of the corpse of every person dying from

Corpses to be kept separate from the living.

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For places not within the Metropolis.

Cholera or Choleraic Diarrhœa, until the time of its interment, and shall cause such means to be adopted for preventing the spread of infection from the corpse as their Medical Adviser shall recommend.

Guardians to take precautions as to ships and vessels lying within their Union or Parish.

19. *If the Guardians shall be informed that Cholera or Choleraic Diarrhœa exists. or within three days previously has existed, in any Ship or Vessel which may be lying within their Union or Parish, they shall cause the same to be forthwith visited, inspected, and otherwise dealt with, according to the circumstances of the case, in like manner as if it were an inhabited house on shore, and shall give all such medical and other directions in reference to the persons in such Vessel or Ship, as shall be requisite for preventing the spread of the disease, and for the disinfection or disposal of any things which may be infected or may have been exposed to infection, subject always to the provisions of any Order of Council issued under the Quarantine Laws for the time being in force in such Union or Parish.**

Provision for ships or vessels in parts or arms of the sea having Cholera on board.

20. *The captain, master, or other officer in charge of any ship or vessel lying in any part or arm of the sea within the jurisdiction of the Admiralty, but not comprised within any Union or Parish, in which ship or vessel any case of Cholera or Choleraic Diarrhœa exists, or within three days previously has existed, shall obey every direction in writing addressed to him by the Guardians of the nearest Union or Parish signed by their Chairman or Clerk, in reference to the Medical and other treatment of the sick and other persons on board, with the view of preventing the spread of the disease, or to the disposal of the body of any person dead of the disease, or to the disinfection and disposal of the things infected with the disease, or otherwise to the removal of any unhealthy condition of the ship or vessel.†*

Statistical returns to be obtained.

21. The Clerk of the Board shall every Monday send by post to the Medical Officer of the Privy Council, a return of the number of new cases of Diarrhœa or Cholera which have, during the week ended on Saturday midnight last, come under the cognizance of the Board, and of the number of recoveries, and the number of deaths, with such other particulars as such Medical Officer shall from time to time require. The Return shall be in the following form, or to the like effect :—

____________________ *Union or Parish.*

Weekly Return of Cases of Cholera or Diarrhœa for the Week ending on Saturday last.

NEW ATTACKS during the Week - - - - - -
DEATHS during the Week - - - - - - -
RECOVERED during the Week - - - - - -
Total number of Cases NOW UNDER TREATMENT - - -
Date ____________________ 1866.

(Signed) ____________________ *Clerk to the Board.*

Board to publish notices.

22. The Board shall, from time to time, as they shall find expedient, issue, publish, and distribute in placards, hand-bills, or other communications, such admonitory notices to the owners and occupiers of property within their district as to the provisions of the Acts for the Removal of Nuisances as shall appear to be requisite, and in a like manner publish all such medical advice and such directions and instructions as in their judgment shall be necessary to afford aid to persons attacked with Cholera or Diarrhœa, or for the carrying of these Regulations into

* Repealed by Order of Council of Aug. 25, 1866.

execution, and inform the public what special arrangements have been made for affording medical or other assistance in the district.

23. All Officers, Assistants, and Servants of the Board are ordered, and all Medical Practitioners and other persons inhabiting within the district of the Board are requested, to supply information and give their aid to the utmost of their ability to the Board in the execution of these regulations and directions.

General Order and exhortation for aid to the Board.

24. In Parishes and Townships not comprised in a Union or under a separate Board of Guardians, the Clerk, Governor, or the Overseers, as the case may be, shall, so far as they can according to the extent and circumstances of their Parish or Township, carry the foregoing Regulations into execution.

Provision for Parishes not in Union or under a Board of Guardians.

25. The word "Union," as used herein, shall be taken to include not only a Union of Parishes formed under the provisions of an Act passed in the fifth year of the reign of His late Majesty King William the Fourth, entitled "An Act for the Amendment and better Administration of the Laws relating to the Poor in England and Wales," but also any union of Parishes incorporated or united for the relief or maintenance of the poor under any Local Act of Parliament.

Interpretation clause.

And the word "Guardians," as used herein, shall be taken to include not only Guardians appointed or entitled to act under the provisions of the said last-mentioned Act, but also any Governors, Directors, Managers, or Acting Guardians entitled to act in the ordering of relief to the poor from the Poor Rates under any Local Act of Parliament.

b. Directions and Regulations of July 21st, 1866, for Places within the Metropolis.

b. For Places within the Metropolis.

I.—*Preliminary.*

Forthwith on the issuing of the present regulations, the Clerk of every Vestry or District Board (as the case may be) under the Act of the Session holden in the eighteenth and nineteenth years of Her Majesty, chapter one hundred and twenty, shall summon a special meeting of the Vestry or Board, in order that the present regulations may be brought before them, and that the Vestry or Board may make, as they are hereby required to do, such preliminary arrangements as will enable them, if sudden need shall arise, to carry the following regulations into immediate effect; and the Vestry or Board at such meeting shall direct the Clerk, by circular letters of request addressed to all legally qualified Medical Practitioners in the parish or district, and in such other ways as the Vestry or Board may think necessary, to take measures for causing the Vestry or Board to be made acquainted with any presence of Cholera or unusual amount or severity of Diarrhœa in the parish or district, or any part of it, if such be existing or should thereafter exist; and the Vestry or Board, if apprised of any such presence of Cholera or Diarrhœa, shall thereupon forthwith, so far as the circumstances require, do the several things herein-after ordered:

Preliminary arrangements.

II.—*When Cholera is in a Parish or District.*

1. Every Vestry or Board shall make arrangements for meeting, where the disease is actually prevailing, daily, either in a body or in one or more Committees, according to the exigencies of the parish or district, for the purpose of exercising the powers conferred upon them by the Act.

Meetings.

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Place of meeting.

2. The meetings may be held at the ordinary Board-room, and where necessary, at such other places as shall appear to be most convenient for dealing with the disease, and the Vestry or Board shall cause proper minutes of all proceedings to be made and duly recorded.

Medical Officer of Health.

3. The Medical Officer of Health shall, as far as practicable, attend the meetings of the Vestry or Board, and of its Committees, to render his advice thereat, and shall superintend all the medical arrangements for preventing and treating the disease.

Appointment of Medical Visitors and Assistants.

4. In each parish or district in which Cholera is present, or, if the quantity of work to be done renders it desirable to subdivide the parish or district, then in each of such subdivisions a legally qualified Medical Practitioner shall be put in charge of the parish or district or subdivision for the medical purposes of these regulations; and to each such Medical Practitioner (herein-after named the Medical Visitor) shall be allotted such Assistants as the Vestry or Board see fit.

Such Medical Visitor, where practicable, or, in other cases, one of his Assistants, shall at least once daily visit those places assigned to him which are inhabited by the poorer classes and wherein the disease is, and shall there inquire at every house as to the existence of Diarrhœa or Cholera, and shall enter in a book to be kept for the purpose the facts as to all cases he may meet with, and shall without delay give, or take the proper steps for causing to be given, all necessary medical assistance to the sick. And the Medical Visitor or Assistant shall, when visiting the places assigned to him, be provided with medicines for immediate administration in urgent cases, and shall be held to be in medical charge of all cases of Diarrhœa or Cholera with which he may meet until he is relieved by such other provision for their medical attendance as may be made or sanctioned by the Vestry or Board.

Their report.

5. Such Medical Visitor shall, by transmitting his above-required book, or otherwise, report daily to the Medical Officer of Health the result of his own and his Asssistants' inquiries, and shall report any nuisances which he or they find existing in any premises visited by him or them, and shall make such suggestions as to the state of the parish or district as he shall deem advisable.

Visitors to report cases of destitution to the Relieving Officer.

6. The visitors shall, where they find it expedient, communicate to the Relieving Officer of the district any case of destitution requiring relief, which is not entered in his relief list; and such officer shall forthwith visit the same and give such relief as in his judgment the case shall require.

To provide dispensary stations.

7. The Vestry or Board shall provide a sufficient number of dispensaries, to be open night and day, at convenient places within their parish or district, with an adequate supply of such medicines, medical appliances, and disinfectants, as their Medical Officer of Health shall recommend, and with a legally qualified Medical Practitioner or skilled Assistant always in attendance at each; and such medicines, medical appliances, and disinfectants, shall be dispensed without charge by such Medical Practitioner or Assistant to persons bringing orders for the same from the Medical Visitors, and to other persons who apply for immediate medical treatment. And the names and addresses of all such applicants shall be sent to the Medical Visitor of the place in which they reside.

To supply medical aid to poor cholera patients.

8. In every case of Cholera or Diarrhœa, where the patient is not under medical care and treatment, the Vestry or Board shall cause medical assistance to be rendered with the utmost expedition, and such aid, and comfort, nourishment, and accommodation, as the circumstances of the case will admit, with the object of restoring health.

To provide nurses.

9. The Vestry or Board shall provide competent nurses to aid every

Medical Visitor in his attendance upon the patients suffering from the disease.

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To provide hospitals in certain cases.

10. When the Medical Officer of Health recommends, the Vestry or Board shall, with as much despatch as practicable, provide fit and proper accommodation for the reception of such patients as have no home, or cannot properly be treated at home, and may with advantage to themselves be removed, and shall cause the same to be provided, with all appliances, medicines, furniture, and other things necessary for the emergency, and shall appoint a legally qualified Medical Practitioner, with or without Assistant, as the case may require, to attend to the same.

To provide for the separation of the sick from the healthy in the same dwelling.

11. If Cholera or Choleraic Diarrhœa exist in any dwelling whereof the Medical Officer of Health reports that the sick and healthy cannot therein be properly separated, the Vestry or Board shall forthwith cause adequate accommodation to be procured for the reception of the healthy; and, when the Medical Officer of Health recommends that the sick person shall not be removed, but that the healthy shall be removed from the same room in which the sick person is lying, the Vestry or Board shall cause the other inmates of such room to be removed to some convenient place of reception.

To provide disinfectants and to cause things and places to be disinfected.

12. The Vestry or Board shall, in dwellings where Cholera or Diarrhœa exists, cause proper disinfectants to be used in sufficient quantities for the purpose of disinfecting the discharges from the sick, and the bedding, clothing, and other things thereby infected, and the utensils and privies in which such discharges may have been received.

To cause infected goods to be destroyed.

13. The Vestry or Board shall cause every article of clothing, bedding, or furniture which shall have been infected with any such discharge, and which they shall find incapable of being speedily disinfected, to be forthwith destroyed, the Vestry or Board within a reasonable time replacing all such articles, or paying the reasonable value to the owner.

To procure good water in place of that which is polluted.

14. If it be shown to the Vestry or Board that any drinking-water used in their parish or district is polluted, they shall take measures, with as much expedition as possible, for procuring wholesome water to be supplied in its stead, so far as the case requires, to the inmates of the houses in their parish or district, and for preventing, as far as possible, the further use of the polluted water. And every Vestry or Board owning or having possession of any waterworks for the supply of water shall cause the reservoirs, cisterns, pipes, pumps, and other apparatus belonging thereto, to be carefully examined, cleansed, and purified, and other necessary measures to be taken, so that the water may be supplied without impurity.

Provision for burials.

15. The Vestry or Board shall make due arrangements with undertakers, and with the proper authorities of the churchyards, burial grounds, and cemeteries of their parish or district, so that coffins may be ready to be supplied immediately on demand, and interments speedily take place in the cases of deaths arising from Cholera or Diarrhœa; and the Vestry or Board shall, when informed of any such death, cause the corpse to be buried with the earliest possible despatch.

Assemblage of persons at waking the dead prohibited.

16. Where any death shall occur from Cholera or Choleraic Diarrhœa, no collection of persons shall assemble in the room where the corpse is, and no "waking" of the dead shall be allowed.

Corpses to be kept separate from the living

17. The Vestry or Board shall cause the immediate removal, from any room which living persons inhabit, of the corpse of every person dying from Cholera or Choleraic Diarrhœa, until the time of its interment, and shall cause such means to be adopted for preventing the spread of infection from the corpse as their Medical Officer of Health shall recommend.

To take precautions as to

18. *If the Vestry or Board shall be informed that Cholera or Choleraic Diarrhœa exists, or within three days previously has existed,*

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ships and vessels lying within their parish or district.

*in any Ship or Vessel which may be lying within their Parish or District, they shall cause the same to be forthwith visited, inspected, and otherwise dealt with, according to the circumstances of the case, in like manner as if it were an inhabited house on shore, and shall give all such medical and other directions in reference to the persons in such Vessel or Ship, as shall be requisite for preventing the spread of the disease, and for the disinfection or disposal of any things which may be infected or may have been exposed to infection, subject always to the provisions of any Order of Council issued under the Quarantine Laws for the time being in force in such Parish or District.**

Statistical returns to be obtained.

19. The Clerk of the Vestry or Board shall, every Monday, send by post to the Medical Officer of the Privy Council a return of the number of new cases of Diarrhœa or Cholera which have during the week ended on Saturday midnight last come under the cognizance of the Vestry or Board, and of the number of recoveries, and the number of deaths, with such other particulars as such Medical Officer shall from time to time require. The return shall be in the following form, or to the like effect :—

______________________ *Parish or District.*

Weekly Return of Cases of Cholera or Diarrhœa for the Week ending on Saturday last.

NEW ATTACKS during the Week - - - -
DEATHS during the Week - - - - -
RECOVERED during the Week - - - -
Total number of Cases NOW UNDER TREATMENT -

Date ______________________ 1866.

(Signed) ______________________ *Clerk to the Vestry or Board.*

To publish notices. [See note to Title.]

20. The Vestry or Board shall, from time to time as they shall find expedient, issue, publish, and distribute in placards, hand-bills, or other communications, such admonitory notices to the owners and occupiers of property within their parish or district as to the provisions of the Acts for the Removal of Nuisances as shall appear to be requisite, and in like manner publish all such medical advice and such directions and instructions as in their judgment shall be necessary to afford aid to persons attacked with Cholera or Diarrhœa, or for the carrying of these Regulations into execution, and inform the public what special arrangements have been made for affording medical or other assistance in the parish or district.

General Order and exhortation for aid to the Vestry or Board.

21. All Officers, Assistants, and Servants of the Vestry or Board are ordered, and all Medical Practitioners and other persons inhabiting within the parish or district of the Vestry or Board are requested, to supply information and to give their aid to the utmost of their ability to the Vestry or Board in the execution of these regulations and directions.

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* Repealed by Order of Council, August 25, 1866, when the following regulations (No. 5, *c.*) were substituted, and when also the application of the Disease Prevention Act was extended to all parts and arms of the sea lying within the jurisdiction of the Admiralty, within three miles of the coasts of England.

c. Amended Regulations as to Shipping

c. AMENDED REGULATIONS of August 25th as to SHIPPING.

1. In this Order—

The term "ship" includes vessel or boat:

The term "master" includes the officer or person for the time being in charge or command of a ship.

The term "cholera" includes choleraic diarrhœa:

The term "Nuisance Authority" has the same meaning as in "The Sanitary Act, 1866:"

2. The Master of every ship within the district of a Nuisance Authority, having on board any person affected with cholera, or the body of any person dead of cholera, or anything infected with or that has been exposed to the infection of cholera, shall, as long as the ship is within such district, moor, anchor, or place her in such position as from time to time the Nuisance Authority directs.

3. If at any time a Nuisance Authority is informed that cholera exists, or within three days previously has existed, in a ship within its district, such authority shall cause the ship to be forthwith visited, inspected, and otherwise dealt with (according to the circumstances of the case), in like manner as nearly as may be as if the ship were a house within the district of such authority, and shall give all such medical and other directions with reference to the persons therein, as seems to such authority requisite or proper for preventing the spread of the disease therefrom, and for disinfection or disposal of any thing infected, or that has been exposed to infection therein or therefrom.

d. MEMORANDUM by the MEDICAL OFFICER of the PRIVY COUNCIL, on the PRECAUTIONS to be taken against CHOLERA, under the REGULATIONS recently issued by the LORDS of the COUNCIL, and otherwise.

d. Memorandum by the Medical Officer.

[N.B. Not long after this memorandum was issued, the state of law described in it, § 6, was essentially changed by the enactment of Vict. 29 & 30, c. 90, commonly known as The Sanitary Act, 1866, and particularly by the 49th section of that Act.—J. S.]

Diseases Prevention Act put in force.

1. Asiatic Cholera, which for more than a year past has again been affecting in succession many parts of continental Europe, has recently shown some disposition to spread in a few parts of England. It is probable that henceforth, for some weeks or months to come, the disease will be seen, in more or less considerable groups of cases, in other parts of this country. It is possible that in some such parts, amid predisposing conditions, the disease may suddenly become of great local importance, and under these circumstances the Lords of Her Majesty's Council have seen fit (by Order, dated July 14th) to put in force the provisions of the Diseases Prevention Act, 1855.

Medical Relief Regulations issued.

2. Also their Lordships have seen fit to issue Regulations under the Act. Those Regulations (contained in two Orders of Council, dated respectively the 20th and the 21st July) direct the appointed local authorities to do in their respective districts, so far as necessary, certain things, which are chiefly of the nature of Medical Relief. The Authorities who have to give effect to those MEDICAL RELIEF REGULATIONS are as follows:—First, within the Metropolis, with exception of the City of London, the respective *Vestries* or *District Boards* of the several parishes or districts; secondly, outside the Metropolis, and also in the three Unions of the City of London, the *Boards of Guardians* or *Overseers of the Poor* of the several Unions, parishes, and places,

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*d.*Memorandum by the Medical Officer.

respectively. The main objects for which the Regulations purport to provide are briefly, and in the words of the Statute, as follows:— "For the speedy interment of the dead; for house to house visitation; for the dispensing of medicines, guarding against the spread of disease, and affording to persons afflicted by or threatened with such epidemic, endemic, or contagious diseases, such medical aid and such accommodation as may be required." In order that these objects should be promptly and adequately fulfilled in any district where Cholera may show itself, it is necessary that all Authorities who will be responsible for fulfilling them should betimes, in their respective districts, pre-consider and pre-arrange the measures which, in case of need, are to be taken. Therefore the Regulations require that in all cases (not only in cases where Cholera is actually present within the jurisdiction) an immediate meeting of the Authority shall be held, and certain preparatory directions be given. But, except to this extent, no action under the Diseases Prevention Act is required of any district, unless Cholera be actually present there.

Removal of nuisances.

3. There are other respects, however, in which local action has to be taken against Cholera, and in which the interests of the public health require, above everything, that the action should be taken from beforehand. This precautionary action against Cholera (as against many other diseases) is an object for which the NUISANCES REMOVAL ACTS enable local provision to be made. The authorities who have to administer these acts are in many places the same, but in many other places (chiefly wherever there are Town Councils, Improvement Commissioners, or Local Boards of Health) are not the same, as the authorities who have to act under the Medical Relief Regulations. The Lords of the Council have no authority to issue regulations or orders for any purposes of the Nuisances Removal Acts. But a year ago, in anticipation of the danger which now threatens the country, their Lordships drew the attention of Nuisance Authorities, and of the public generally, to the renewed presence of Asiatic Cholera in Europe, and suggested the precautionary proceedings which under the circumstances were called for. It was their Lordships' hope, that, after this warning, the interval which might elapse before a re-appearance of Cholera in England would be vigorously used by the Nuisance Authorities of the country in preparing their respective districts for the contingency which has now come. The paper which was circulated on the above occasion by the Lords of the Council (the "General Memorandum on the proceedings which are advisable in places attacked or threatened by epidemic disease") is now again commended by their Lordships to the consideration of Nuisance Authorities and of the public. And, on the present occasion, parts of it must be specially insisted on.

Nuisances specially relative to Cholera.

4. In relation to Asiatic Cholera, as now threatening us, there are two principal dangers against which extreme and exceptional vigilance ought to be used,—First, there is the danger of drinking WATER which is in any (even the slightest) degree tainted by house-refuse or other like kinds of filth: as where there is out-flow, leakage or filtration, from sewers, house-drains, privies, cesspools, foul ditches, or the like, into streams, springs or wells from which the supply of water is drawn or into the subsoil in which the wells are situate: a danger which may exist on a small scale, as at the pump or dip-well of a private house, or on a large scale, as in the sources of supply of public water-works: And secondly, there is the danger of breathing AIR which is made foul with effluvia from the same sorts of impurity. Information as to the high degree in which those two dangers affect the public health in ordinary times, and as to the extreme degree of importance which attaches

to them at times when any diarrhœal disease is epidemic, has now for so many years been set before the public, by this Department and otherwise, that the larger works of drainage and water-supply by which the dangers are permanently obviated for large populations, and also the minor structural improvements by which separate households are secured against the dangers, ought long ago to have come into universal use. It is to be feared that on a very large scale this wiser course has not been adopted, and that even yet, in very many instances, temporary security has to be found in measures of a palliative kind. So far as such is the case, attention is most earnestly called to those parts of the General Memorandum which relate to the matters in hand. All chief sources of the one danger may be held in check as follows :— by immediate thorough removal of every sort of house-refuse and other filth which is now accumulated ; by preventing future accumulations of the same sort ; by attention to all defects of house-drains and sinks through which offensive smells are let into houses ; by thorough washing and lime-whiting of uncleanly premises, especially of such as are densely occupied ; and by disinfection, very freely and very frequently employed, in and round about houses, wherever there are receptacles or conduits of filth, wherever there is filth-sodden porous earth, wherever anything else, in, or under, or about the house tends to make the atmosphere foul. As provision against the other danger, it is essential that immediate and searching examination of sources of water supply should be made in all cases where the source is in any degree open to the suspicion of impurity : examination both of private and of public supplies : and that where pollution is discovered, everything practicable should be done to prevent the pollution from continuing, or, if this object cannot be attained, to prevent the water from being drunk. The examination of sources of water supply should of course extend to all receptacles of water-storage, such as the tanks and reservoirs of public supply, and the butts and cisterns of private houses.*

Mode of propagation of Cholera.

5. That such precautions as the above (never unimportant where human health is to be preserved) are supremely important when the spread of Cholera is to be prevented, is a truth which will best be understood when the manner in which Cholera spreads is considered Happily for mankind, Cholera is so little contagious, in the sense in which small-pox and typhus are commonly called contagious, that, if proper precautions are taken where it is present, there is scarcely any risk that the disease will spread to persons who nurse and otherwise closely attend upon the sick. But Cholera has a certain peculiar contagiousness of its own, now to be explained ; which, where sanitary circumstances are bad, can operate with terrible force, and at considerable distances from the sick. It appears to be characteristic of Cholera —not only of the disease in its developed and alarming form, but equally of the slightest Diarrhœa which the epidemic influence can produce, that *all matters which the patient discharges from his stomach*

* If unfortunately the only water which for a time can be got should be open to suspicion of dangerous organic impurity, it ought at least to be boiled before it is used for drinking, but then not to be drunk later than twenty-four hours after it has been boiled. Or, under medical or other skilled direction, water, in quantities sufficient for one day's drinking in the house, may be disinfected by a very careful use of Condy's red disinfectant fluid. This should be added to the water (with stirring or shaking) in such number of drops that the water, an hour afterwards, shall have the faintest pink colour which the eye can distinctly perceive. Filtering of the ordinary kind cannot by itself be trusted to purify water, but is a good addition to either of the above processes. It cannot be too distinctly understood, that dangerous qualities of water are not obviated by the addition of wine or spirits.

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d. Memorandum by the Medical Officer.

and bowels are infective; that the patient's power of infecting other persons is represented almost or quite exclusively by those discharges; that they, however, are comparatively non-infective at the moment when they are discharged, but afterwards, while undergoing decomposition, acquire their maximum of infective power; that, if they be cast away without previous disinfection, they impart their own infective quality to the excremental matters with which they mingle, in filth-sodden earth or in depositaries and conduits of filth, and to the effluvia which those excremental matters evolve; that, if the infective material, by leakage or soakage from drains or cesspools, or otherwise, gets access, even in the smallest quantity, directly or through porous soil, to wells or other sources of drinking-water, it can infect, in the most dangerous manner, very large volumes of the water; that the infective influence of choleraic discharges attaches to whatever bedding, clothing, towels, and like things, have been imbued with them, and renders these things, if not disinfected, capable (as the cholera-patient himself would be capable, under the same conditions) of spreading the disease in places whither they are sent for washing or other purposes; that, in the above described ways, even a single case of disease, perhaps of the slightest degree, and perhaps quite unsuspected in its neighbourhood, may, if local circumstances co-operate, exert a terribly infective power on considerable masses of population. "If local circumstances co-operate," however, is the stated condition for that possibility; and it will be observed that the essence of the sanitary precautions, which have been recommended to Nuisance Authorities and others, is to annihilate those "local circumstances." The choleraic infection does not seem able largely to injure any population unless a filthy state of things be presupposed. It is pre-supposed that the atmosphere or the drinking-water of the population is impure with the most loathsome of impurities,—that the infective material has had opportunities of action which decent cleanliness would not have afforded it,—that, in inefficient drains or cesspools or other like depositaries, it has had time to develop its own infective power, and to render other stagnating filth equally infective with itself,—and that, from such foci of infection, the disgusting leaven of the disease has spread, in air or water, to be breathed or swallowed by the population. In this view of the case, it will be understood that works of sewerage, house-drainage and water-supply, properly executed and properly used, give to town-populations an almost absolute security that Cholera, if introduced among them, can have no means of spreading its infection. And equally it will be understood that, in the absence of those permanent safeguards, no approach to such security can be got without incessant cleansings and disinfections, or without extreme vigilance against every possible contamination of drinking-water.

Jurisdiction in removal of nuisances.

6. It is highly important that the public should not be under any misapprehension as to the course by which the above-defined sanitary objects (so far as the law provides for them) may be attained. The administration of the Nuisances Removal Acts is a matter of exclusively local jurisdiction. Over the various NUISANCE AUTHORITIES, in whose hands it is vested, neither the Privy Council, nor any other department of Her Majesty's Government, is empowered to exercise control. The authorities in question are elective bodies, chosen as their constituencies will; and each constituency, in exercising its electoral right, has, in effect, the means of deciding for itself whether the district which it inhabits shall be wholesomely or unwholesomely kept. The Lords of the Council have no other function appointed for them in this matter than to inquire, and afterwards report to Parliament, what, so far as the public health is concerned, is the working of that system of admi-

nistration. Incidentally to the performance of that function, their Lordships have before them the result of much former experience, in this country and elsewhere, as to the circumstances by which the spread of Cholera is determined; and having this experience, their Lordships have seen fit that its more important conclusions should be so set forth as to give to Nuisance Authorities the best assistance which this department can supply towards the task of locally dealing with the removable causes of the disease. But here their Lordships' power terminates. Their Lordships can only hope that Nuisance Authorities, having undivided and sole responsibility in the matter, will justify that very ample trust which the legislature has seen fit to repose in them; and for the inhabitants of places where the Nuisance Authorities do not take proper measures for the protection of the public health, the Lords of the Council, in the present state of the law, can only suggest that voluntary associations should, as far as practicable, endeavour to supply the defect. Where nuisances on private premises require to be summarily dealt with, complaint may be laid by any inhabitant of the parish or place before any justice of the peace having jurisdiction there; but complaints addressed to this or any other Government office cannot lead to coercive interference, and may involve loss of valuable time. Of course, too, it must be remembered that, however active may be the authority or any committee acting in its stead, every householder ought at least to be vigilant as to the state of his own premises and water-supply.

Personal precautions as to local circumstances.

7. Personal precautions against Cholera consist essentially in avoiding the unwholesome circumstances which have been described; and where that avoidance can be secured, there needs not be further thought on the subject. Even where Cholera seems imminent, the danger is quite conspicuously one which ought not to give occasion to panic. Intelligence and cool decision are wanted against it. The case is no longer that of a mysterious pestilence coming (like the plagues of past centuries) on ignorant and but half-socialised populations; it is the case of a distinct and measurable attack, against which definite precautions can be taken with success; and power to enforce those precautions is in the hands of local authorities throughout the country. But individual security cannot be promised apart from the security of districts, and for selfish safety, no less than for the general good, it is expedient that every man should do his utmost to promote where he dwells a vigorous sanitary administration over the largest possible area. Those who know that such an administration is at work around them need have but little apprehension as to the result.

Personal precautions as to diet, &c.

8. As to personal precautions, in a narrower sense of the words, only one general rule can be laid down: a rule, however, which is most important for persons who unfortunately find themselves in the midst of local outbreaks of cholera, and which each individual must apply according to his experience of his own bodily habits: the rule of living as strictly as possible on that system which commonly agrees best with the health; to guard, as far as practicable, against all exhausting influences of privation, fatigue, exposure, and the like; and, as regards diet, especially to avoid all acts of intemperance, and all such eating and drinking as are likely to disturb the stomach or bowels.* But while

* Precautions against causing such disturbance to oneself by errors of diet will vary somewhat with different individuals. Every person of ordinary discretion knows the habits of his own body, and can be tolerably confident, within certain limits of food, that he gives himself no occasion of such illness. Apart from personal peculiarities (where each man must judge for himself) the chief dangers of diet appear to lie as follows:—first, in those mere excesses of diet which (especially under circumstances

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faults of the latter kind are peculiarly apt to be hurtful, it must not therefore be supposed that the customary healthful habits need be changed. For instance, there is no reason to suppose that fruits and vegetables, of such kinds and in such states as would be wholesome in ordinary seasons, are unwholesome when Cholera is present; nor (subject to what will directly be said about premonitory diarrhœa) is there any reason to believe that persons in good health ought in Cholera times, with a notion of fortifying themselves against the disease, to take drugs or drams which they would not take in ordinary times. Anything to be wisely done in this direction ought to be done under the advice of skilled medical practitioners, and, except with such advice, people ought to be most chary both of drugging themselves and of taking such pretended preservatives as are extensively offered for sale.

Premonitory diarrhœa.

9. In places where Cholera is present or threatening, one particular bodily ailment requires exceptional vigilance. That ailment is Diarrhœa. For the most part in this country Cholera begins somewhat gradually; so that, for some hours or even days before the symptoms become alarming, a so-called "premonitory diarrhœa" may be observed. Where Cholera is tending to be epidemic, there always exists, side by side with it in the district, a large amount of epidemic diarrhœa, representing in part the earlier stages, in other part the slighter degrees, of the same insidious and infectious malady. This Diarrhœa (painless and apparently trivial though it be) may in any case suddenly convert itself into Cholera; and, apart from the very serious significance of the symptom as regards the patient himself, it must be remembered that every such diarrhœal patient may be a well-spring of infection to others. It also seems probable that accidental diarrhœa, originally independent of the epidemic influence, is, of all known personal conditions, the one on which the cholera infection can most easily fix itself. And thus on all accounts it is of the most essential importance that no looseness of bowels should be neglected in places where cholera exists. A very important part of their Lordships' Medical Relief Regulations enjoins the making of local arrangements by which this object shall be secured for all the poorer inhabitants of infected districts; and other classes of the population are warned to be also vigilant for themselves. In any infected district, every looseness of bowels, or sickness of stomach, ought, as quickly as possible, to be brought under skilled medical treatment; and if the symptoms begin at all sharply, or if they (however mild) do not very promptly yield to treatment, the patient ought invariably to remain in bed.

Disinfection.

10. Too much importance cannot be attached to the duty of thoroughly disinfecting, without delay, with chloride of lime or otherwise, all discharges from the stomach and bowels of persons under the epidemic influence, as well as all bedding, clothing, towels and the like, which such discharges may have imbued. And measures, as advised in section 4, for keeping all privies and like places in a thoroughly clean and uninfected state, become more and more important in proportion as the

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of fatigue) occasion sickness to the stomach, or an increased labour of digestion; secondly, in taking food, solid or fluid, which is midway in some process of chemical transition—half-fermented beer and wine, water containing organic impurities, meat and game and venison no longer fresh and not completely cooked, fish and shellfish in any state but the most perfect freshness, fruit or vegetables long-gathered or badly kept, and the like; thirdly, in the excessive or unseasonable use of refrigerant drinks or ice; fourthly, in partaking largely of those articles of diet which habitually, or by reason of imperfect cooking, pass unchanged through the intestinal canal; and fifthly, in the indiscreet use of purgative medicines, or in taking any article of diet which is likely to produce the same effect.

discnarges in question are likely to have access to the places. [For detailed advice on Disinfection, see the Office Memorandum on that subject.]

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d. Memorandum by the Medical Officer.

Organization for medical relief in infected districts.

11. With reference to the medical care of the sick, and to all such other kinds of medical action and organization as the circumstances of infected districts may require, the Lords of the Council have every hope and belief that the appointed Medical Relief Authorities of the country will be duly conscious of the very grave responsibility which is thrown upon them by the Diseases Prevention Act and the Regulations thereunder issued, and will be anxious to acquit themselves of the responsibility in a manner commensurate with its importance. But if unhappily any particular district should suffer a sudden and extensive epidemic, it may be that the Authority, though with every disposition to discharge its duty, will have difficulty in providing for all requirements of the case, and will be in danger of finding itself over-tasked. It is to be hoped that in any such crisis, if anywhere it should arise, voluntary local assistance will not be wanting to the Authority. Among the duties which would have to be discharged, some do not require skilled officers, but may with equal propriety be devolved on any discreet and intelligent persons; and it might be of great local service that such persons, in committees or otherwise, should be ready to co-operate with the Authority. Especially the Authority would then be enabled to extend, beyond limits which would else be possible, that system of House-to-House Visitation which in various ways may be the most important of local agencies for stopping the progress of an epidemic: not only as providing for the prompt medical treatment of the sick, but equally as spreading information and exercising influence against conditions which tend to multiply the disease. Apart from action which may be wanted to supplement any inaction of the Nuisance Authority, the room for voluntary work in aid of the Medical Relief Authority may, in the supposed circumstances, be very great:—the local arrangements for medical relief have to be told and explained; the proper use of disinfectants has to be taught and enforced; many other sorts of useful information have to be given; unreasonable alarm has to be quieted; the less educated and the destitute parts of the population have to be led and assisted to do what is needful for their safety. The larger the staff of competent visitors who can be employed in any infected district, the easier will be this task. And any educated person who would wish to take part in it can easily qualify himself to render, in case of need, a really important service to his neighbourhood.

By direction of the Lords of the Council.

(Signed) John Simon.

Medical Department of the Privy Council Office;
8, *Richmond Terrace, London, S.W.*
July 24th, 1866.

e. General Memorandum on the Proceedings which are advisable in Places attacked or threatened by Epidemic Disease.

e. General Memorandum.

1. Wherever there is prevalence or threatening of cholera, diphtheria typhus, or any other epidemic disease, it is of more than common importance that the powers conferred by the Nuisances Removal Acts, and by various other laws for the protection of the public health, be well exercised by those in whom they are vested.

2. If the danger be considerable, it will be expedient that local authorities, in taking measures against it, avail themselves of the best medical advice which their district or its neighbourhood can supply.

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e. General Memorandum.

3. Proper precautions are equally proper for all classes of society. But it is chiefly with regard to the poorer population, therefore chiefly in the courts and alleys of towns, and at the labourers' cottages of country districts, that local authorities are called upon to exercise vigilance, and to proffer information and advice. Common lodging-houses, and houses which are sub-let in several small holdings, always require particular attention.

4. Wherever there is accumulation, stink, or soakage of house-refuse, or of other decaying animal or vegetable matter, the nuisance should as promptly as possible be abated, and precaution should be taken not to let it recur. Especially all complaints which refer to sewers and drains, or to foul ditches, and ponding of drainage, or to neglect of scavenging, should receive immediate attention. The trapping of house-drains and sinks, and the state of cesspools and middens, should be carefully seen to. In slaughter-houses, and other places where beasts are kept, strict cleanliness should be enforced.

5. In order to guard against the harm which sometimes arises from disturbing heaps of offensive matter, it is often necessary to combine the use of chemical disinfectants with such means as are taken for the removal of filth ; and in cases where removal is for the time impossible or inexpedient, the filth should always be disinfected. Disinfection is likewise desirable for unpaved earth close to dwellings, if it be sodden with slops and filth. Generally, where cholera or typhoid fever is in a house, the privy requires to be disinfected.

6. Sources of water-supply should be well examined. Those which are in any way tainted by animal or vegetable refuse, above all, those into which there is any leakage or filtration from sewers, drains, cesspools, or foul ditches, ought no longer to be drunk from. Especially where the disease is cholera, diarrhœa, or typhoid fever, it is essential that no foul water be drunk.

If unfortunately the only water which for a time can be got should be open to suspicion of dangerous organic impurity, it ought at least to be boiled before it is used for drinking, but then not to be drunk later than twenty-four hours after it has been boiled. Or, under medical or other skilled direction, water, in quantities sufficient for one day's drinking in the house, may be disinfected by a very careful use of Condy's red disinfectant fluid, which should be added to the water (with stirring or shaking) in such number of drops that the water, an hour afterwards, shall have the faintest pink colour which the eye can distinctly perceive. Filtering of the ordinary kind cannot by itself be trusted to purify water, but is a good addition to either of the above processes. It cannot be too distinctly understood that dangerous qualities of water are not obviated by the addition of wine or spirits.

7. The washing and lime-whiting of uncleanly premises, especially of such as are densely occupied, should be pressed with all practicable dispatch.

8. Overcrowding should be prevented. Especially where disease has begun, the sick-room should, as far as possible, be free from persons who are not of use or comfort to the patient.

9. Ample ventilation should be enforced. It should be seen that window-frames are made to open, and that windows are sufficiently opened. Especially where any kind of infective fever has begun, it is essential, both for patients and for persons who are about them, that the sick-room and the sick-house be constantly well traversed by streams of fresh air.

10. The cleanliest domestic habits should be enjoined. Refuse-matters which have to be cast away should never be let linger within

doors, and things which have to be disinfected or cleansed should always be disinfected or cleansed without delay.

11. Special precautions of cleanliness and disinfection are necessary with regard to infective matters discharged from the bodies of the sick. Among discharges which it is proper to treat as infective, are those which come, in cases of small-pox, from the affected skin; in cases of cholera and typhoid fever, from the intestinal canal; in cases of diphtheria, from the nose and throat; likewise, in cases of any eruptive or other epidemic fever, the general exhalations of the sick. The caution which is necessary with regard to such matters must, of course, extend to whatever is imbued with them; so that bedding, clothing, towels, and other articles, which have been in use by the sick, do not become sources of misch'ef, either in the house to which they belong, or in houses to which they are conveyed. Moreover, in typhoid fever and cholera, the evacuation should be regard as capable of communicating an infectious quality to any night-soil with which they are mingled in privies, drains, or cesspools; and this danger is best guarded against by thoroughly disinfecting them before they are thrown away: above all, they must never be cast where they can run or soak into sources of drinking water.

12. All reasonable care should be taken not to spread infective disease by the unnecessary association of sick with healthy persons. This care is requisite, not only with regard to the sick-house, but likewise with regard to day-schools and other establishments wherein members of many different households are accustomed to meet.

13. Where dangerous conditions of residence cannot be promptly remedied, it will be best that the inmates, while unattacked by disease, remove to some safer lodging. If disease begins in houses where the sick person cannot be rightly circumstanced and tended, medical advice should be taken as to the propriety of removing him to an infirmary or hospital. In extreme cases, special infirmaries may become necessary for the sick, or special houses of refuge for the endangered.

14. Privation, as predisposing to disease, may require special measures of relief.

15. In certain cases, special medical arrangements are necessary. For instance, as cholera in this country almost always begins somewhat gradually in the comparatively tractable form of what is called "premonitory diarrhœa," it is essential that, where cholera is epidemic, arrangements should be made for affording medical relief without delay to persons attacked, even slightly, with looseness of bowels. So again, where small-pox is the prevailing disease, it is essential that all unvaccinated persons (unless they previously have had small-pox) should very promptly be vaccinated; and re-vaccination should also be offered, both to persons above puberty who have not been vaccinated since childhood, and to younger persons whose marks of vaccination are unsatisfactory.

16. It is always to be desired that the people should, as far as possible, know what real precautions they can take against the disease which threatens them, what vigilance is needful with regard to its early symptoms, and what (if any) special arrangements have been made for giving medical assistance within the district. Especially in case of small-pox or of cholera, such information ought to be spread abroad by printed hand-bills or placards. In any case where danger is great, house-to-house visitation by discreet and competent persons may be of the utmost service, both in quieting unreasonable alarm, and in leading or assisting the less educated and the destitute parts of the population to do what is needful for safety.

17. The present memorandum relates to occasions of emergency.

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Therefore the measures suggested in it are all of an extemporaneous kind; and permanent provisions for securing the public health have not been in express terms insisted on. It is to be remembered, however, that in proportion as a district is habitually well cared for by its Sanitary Authorities, the more formidable emergencies of epidemic disease are not likely to arise in it.

e. General Memorandum.

18. For detailed advice on Disinfection, see the Office Memorandum on that subject.

JOHN SIMON.

f. MEMORANDUM ON DISINFECTION.

f. Memorandum on Disinfection.

N.B.—*It is to cleanliness, ventilation, and drainage, and the use of perfectly pure drinking water, that populations ought mainly to look for safety against nuisance and infection. Artificial disinfectants cannot properly supply the place of those essentials, for, except in a small and peculiar class of cases, they are of temporary or imperfect usefulness. That no house-refuse, not only no excremental matter but also no other kind of dirt or refuse, should remain on or about inhabited premises, is a first rule against infection. That the air within the house should never in any part of the house be stagnant, but should always be in course of renewal from without by uninterrupted and abundant supplies of fresh air, is a condition of equal importance. And that all water meant to be used for drinking or cooking should be drawn from sources which cannot have been polluted by any kind of refuse-matter, is a third most important rule for the avoidance of infection.*

If dwelling-places have within them any odour of drainage, particular examination should be made (1) *whether the filth which house-drains are meant to carry away is retained in or near the premises in ill-made drains, or sewers, or cesspools, or perhaps is leaking from house-drains within the house; and* (2) *whether, inside the house, the inlets of drains and sinks are properly trapped; and* (3) *whether the drains and sewers are sufficiently ventilated outside the house. All waterclosets within houses should have free openings for ventilation from and into the outer air. Of a cesspool, the only true disinfection is to abolish it. In country places, where proper drainage is not provided, the nuisance of open privies may be best avoided by the use of the so-called earth-closet.*

If a sewer is much complained of, as stinking into the public way, generally the presumption is, that, from original ill-construction or some other cause, it does not properly fulfil its object, but has filth accumulated and stagnant in it; and such a sewer, besides occasioning nuisance in the public way, may be the source of serious danger to the inhabitants of houses which drain into it. It is most important that all sewers should be well ventilated at points where their effluvia will be least injurious; and ordinary drain-pipes may be used to conduct the effluvia to a distance.

For convenience, in this memorandum, the word "disinfectants" is used to cover, not only those true disinfectants which permanently destroy infective matter, but also those agents which merely arrest the process, or absorb the offensive products, of organic decomposition.

For artificial disinfection on a large scale, *the agents which most commonly prove useful* are—quick-lime, chloride of lime, carbolic acid, sulphate of iron, perchloride of iron, and chloride of manganese. The following are also efficient disinfectants, but, as being dearer, are less suited, for large operations: sulphate of zinc, chloride of zinc, chloride of soda, and permanganate of potash. In certain cases chlorine gas, or nitrous acid gas, or sulphurous acid gas, may advantageously be used; and, in certain other cases, powdered charcoal or fresh dry earth.

Quick-lime ought to have been recently burnt, and may be used either in the form of dry powder, or stirred up with about ten times its bulk of water as milk of lime. *Chloride of lime* is best used with water, and thoroughly mixed with it, in the proportion of a pound to the gallon; or, of the solution, as commonly sold, about two pints may be mixed with a gallon of water. *Carbolic acid* (in the fluid form in which it is commonly sold) should be dissolved in about eighty times its volume of water, with which it must be mixed by strong shaking in a closed vessel. *Sulphate of iron* should be dissolved in ten times its weight of water; a solution which is best effected by employing hot water and stirring. Of *perchloride of iron* and *chloride of manganese*, the common concentrated solutions may be used, diluted with ten or twleve times their bulk of water. *Sulphate of zinc* should be dissolved in about ten times its weight of warm water. Of *chloride of zinc*, the common concentrated solution may be diluted with eight or ten times its bulk of water.* Of *chloride of soda*, the common solution may be used like that of chloride of lime. Of *permanganate of potash*, an ounce may be dissolved in a gallon of water.†

All disinfectants must be used in *quantities proportionate* to the amount of matter or surface to be disinfected. When the matters requiring to be disinfected have an offensive smell, the disinfectant should be used till this smell has entirely ceased, and as often as the smell recurs, the disinfectant must again be used.

1. During the *emptying of privies and cesspools*, and whenever else temporary disinfection is required for them, carbolic acid, or sulphate of iron, or perchloride of iron, or chloride of manganese, or chloride of zinc, will be found available. A dilute solution (as above) of one of those agents should be poured into the privy or cesspool, from a quart to a pailful at a time, till the desired effect is obtained. Especially where cholera or typhoid fever is present, privies and cesspools ought to be very frequently flooded in this manner. The best test of their being adequately disinfected is the entire absence of fæcal or ammoniacal odour.

2. *Heaps of manure or other filth*, if it be for the time impracticable or inexpedient to remove them, should be covered, to the depth of two or three inches, with a layer of freshly burnt vegetable charcoal in powder. Freshly burnt lime may be used in the same way, but is less effective than charcoal. If neither charcoal nor lime be at hand, the filth should be covered with a layer, some inches thick, of clean dry earth. For a *privy which has only solid contents*, the same sort of treatment is applicable. *Earth near dwellings*, if it has become offensive or foul by the soakage of decaying animal or vegetable matter, should be treated on the same plan.

3. If *running sewage*, about to be used in agriculture, require to be disinfected, the chloride of manganese or perchloride of iron may be best used;‡ but if the sewage is to pass into a river, or into any pond or canal,

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* Or the preparations respectively known as Burnett's and Crewe's disinfectant solutions may be employed.

† Or Condy's disinfectant fluids, which contain manganic and permanganic salts, may be used.

‡ In some such cases McDougall's process, as practised by him at Carlisle, may be applicable; and his powder may also be applicable to cases mentioned in § 1.

where it might again become offensive, chloride of lime is to be preferred and in this case a pound of good chloride of lime will generally suffice to disinfect 1,000 gallons of the sewage. For foul ditches and other stagnant drainage, chloride of lime is also the proper disinfectant.

4. Where it is desirable to disinfect, before throwing away, the *evacuations from the bowels of persons suffering from cholera or typhoid fever,* some of the disinfectant (which here may best be chloride of lime) should be put into the bed-pan or other vessel before it is used by the patient, and some more should be added immediately after. Its thorough mixture with the evacuation should be ensured. Care should also be taken that portions of the discharges do not remain about the patient's body or in his dress.

5. *Linen and Washing Apparel* requiring to be disinfected may be set to soak in water containing per gallon about an ounce either of the common clear solution of chloride of lime or of that of chloride of soda. Or the articles in question may be plunged into boiling water, and afterwards, when at wash, be actually boiled in the washing water.

6. *Woollens, Bedding, or Clothing* which cannot be washed, may be disinfected by exposure for two or more hours, in chambers constructed for the purpose, to a temperature of F. 210°-250°. When this cannot be done, the natural disinfecting process of prolonged exposure to air, sun, and rain, ought to be had recourse to.

7. For the disinfection of the *interior of houses*, the ceilings and walls should be washed with warm quick-lime water. The woodwork should be cleansed with soap and water, and subsequently washed with water containing in each gallon about two ounces of the clear solution of either chloride of lime or chloride of soda.

8. *A room no longer occupied* may be disinfected by chlorine gas, or nitrous acid gas, or sulphurous acid gas. And for this purpose the gases may be produced in the room as follows :—*chlorine gas*, by pouring over a quarter of a pound of finely powdered black oxide of manganese, contained in a jar, half a pint of muriatic acid previously mixed with a quarter of a pint of water ; or by pouring over a quarter of a pound of chloride of lime, contained in a jar, a quarter of a pint of muriatic or dilute sulphuric acid ;—*nitrous acid gas*, by pouring over an ounce of copper shavings or turnings, contained in a deep jar, three ounces of concentrated nitric acid ;—*sulphurous acid gas*, by burning an ounce or two of flowers of sulphur in a pipkin. The process of disinfecting a room by any of these gases requires several hours ; and while it is going on, all doors, chimneys, and windows of the room must be kept carefully closed. Precautions to this effect should have been taken before the chemicals are mixed, as the person who starts the process (having to avoid the gases) must not afterwards loiter in the room. When the process is at an end, doors and windows should be fully opened.

9. *Ships* (except the class of cattle-ships for which special treatment is required) may be disinfected on the same plan as houses. The process should be conducted as distantly as may be from the shore and from other vessels. All the compartments of the ship should first be fumigated with some disinfectant gas, best with chlorine or nitrous acid, and then all the accessible woodwork (in and out) should be washed with a solution of chloride of soda or lime. The bilges require particular attention, and before they are first pumped some pounds of chloride of lime in water, or some gallons of solution of perchloride of iron, should be poured into them, for the purpose of disinfecting the bilge-water. All permanent shingle and small-grained ballast should be replaced by fresh.

It is most frequently with reference to the infection of yellow fever that ships require to be disinfected, and generally in such cases the cargo

requires the same treatment as the ship. So far, therefore, as the cargo has not been completely disinfected in the course of the disinfection of the ship, and so far as is practicable, it ought, before it is landed, and part by part as it is moved, to be disinfected by free sprinklings with the solution of chloride of lime or soda. Also in these cases it is to be remembered that persons from on board the infected ship (especially those who have been most in its hold) may carry infection about their persons—in precaution against which danger it is desirable that the persons should have complete baths of soap and water and that their clothes should partake of the general fumigation of the ship. The person who conducts the fumigation of a ship (especially where there is question of yellow fever) ought not at first to enter the hold, but merely to hang down the hatches, or otherwise place within the hold, the vessel which contains his chemical mixture.

JOHN SIMON.

No. 6.—*Specimen of Weekly Cholera Returns under the Regulations of the Privy Council.*

SUMMARY of the RETURNS made by Clerks of Local Authorities to the Medical Officer of the Privy Council for the Week ending September 15th, 1866, as to Cholera and Diarrhœa in the respective Unions, Parishes, and Districts.

Districts.	New attacks during the week.	Deaths during the week.	Recovered during the week.	Total number of cases now under treatment.
Alverstoke Parish - -	11	0	12	13
Barton-on-Irwell Union -	55	5	17	59
Bedminster Union - -	1 ch. 4 ch. diar. 130 diar.	0	119	1 ch. 2 ch. diar. 11 diar.
Bedwellty Union - -	30	10	13	41
Blean Union - - -	2 ch. 29 diar.	2 ch. 1 diar.	12	16
Bolton Union - - -	7	4	0	3
Bradford Union - -	79	4	57	20
Bridgend and Cowbridge Union	27 ch. 39 diar.	7 ch. 1 diar.	14 ch. 37 diar.	6 ch. 35 diar.
Brighton Parish - -	15 diar.	0	22	10
Bristol Incorporation - -	4 ch. 2 ch. diar. 163 diar.	1 ch.	141 diar.	3 ch. 2 ch. diar. 52 diar.
Bromley Union - -	9	0	5	7
Bury Union (Lancashire) -	10	1	9	10
Carmarthen Union - -	130	7	80	64
Clifton Union - - -	5 ch. 293 diar.	1 ch.	2 ch. 318 diar.	3 ch. 13 diar.
Crediton Union - -	19	1	17	12
Darlington Union - -	2	2	0	0
Dover Union - - -	9	2 Eng. ch.	0	No return.
East Ashford Union - -	3 ch. 16 diar.	2	1 ch. 6 diar.	No return.
Eastry Union - - -	17	2	15	0
Epping Union - - -	2 ch. diar.	0	0	2 ch. diar.
Exeter Incorporation - -	207	16	9	101
Faversham Union - -	24	1	45	27

APPENDIX.

No. 6.
Weekly Returns of Cholera and Diarrhœa.

Districts.	New attacks during the week.	Deaths during the week.	Renewed during the week.	Total number of cases now under treatment.
Glanford Brigg Union -	28	1	23	33
Goole Union - - -	52	12	51	15
Gower Union - - -	17	3	10	13
Halifax Union - - -	11 Eng. ch. 108 diar.	1 Eng. ch.	7 Eng. ch. 104 diar.	4 Eng. ch. 29 diar.
Hartlepool Union - -	2 ch. 1 diar.	1	4	1
Hastings Union - -	3	1	0	2
Huddersfield Union - -	50	1	41	34
Kidderminster Union - -	0	0	2	0
Leigh Union - - -	3	1	1	2
Leighton Buzzard Union -	14 ch. 37 diar.	8 ch.	2 ch. 17 diar.	4 ch. 20 diar.
Liverpool Parish - -	203 ch. 147 diar.	95 ch. 3 diar.	58 ch. 127 diar.	106 ch. 51 diar.
Liverpool (Toxteth Park Township).	300	11	292	103
Liverpool (West Derby Union)	803	40	800	82
Llanelly Union - -	56	13	49	28
Maidstone Union - -	33	10	6	18
Malling Union - -	1 ch. 3 diar.	1 ch.	0	3 diar.
Merthyr Tydfil Union - -	906	51	722	288
Melton Union - - -	82	2	85	6
Metropolitan Parishes and Districts altogether:				
Bethnal Green District -	1,082	22	850	210
Chelsea Parish - -	271	0	325	105
City of London Union -	73 diar.	0	No return.	
Clerkenwell Parish - -	2 ch. 102 diar.	1 ch. 3 diar.	104	8
East London Union - -	13 ch. 23 ch. diar. 105 diar.	6 ch.	4 ch. 6 ch. diar. 66 diar.	5 ch. 14 ch. diar. 72 diar.
Fulham District - -	11	0	9	3
Greenwith District - -	376	16	238	238
Hackney District - -	300	9	No return.	
Holborn District - -	1 ch. 97 diar.	1 ch.	60 diar.	17 diar.
Islington Parish - -	9 ch. 8 ch. diar.	4 ch.	No return.	
Kensington Parish - -	172	1	119	66
Lambeth District - -	3 ch. 13 ch. diar. 339 diar.	1 ch. 1 ch. diar.	2 ch. 12 ch. diar. 358 diar.	3 ch. 9 ch. diar. 64 diar.
Limehouse District - -	73	3	72	73
Mile End Old Town Parish -	131	1	70	60
Paddington Parish - -	122	0	86	36
Plumstead District - -	1	1	No return.	
Poplar District - -	9 ch. 701 diar.	12 ch. 1 diar. 3 inf. diar.	8 ch. 437 diar.	319
St. George-in-the-East Parish	7 ch. 68 diar.	3 ch.	14 ch. 78 diar.	2 ch. 33 diar.
St. Giles' Parish - -	4 ch. 4 ch. diar. 569 diar.	5 ch.	3 ch. 4 ch. diar. 604 diar.	2 ch. 1 ch. diar. "44 & others."
St. Pancras Parish - -	10 ch. 5 ch. diar. 890 diar.	9 ch.	"Unknown."	
Shoreditch Parish - -	10 ch. 58 ch. diar. 563 diar.	"See Registrar-General's Return."		"Unknown."

APPENDIX.

No. 6.
Weekly Returns of Cholera and Diarrhœa.

Districts.	New attacks during the week.	Deaths during the week.	Renewed during the week.	Total number of cases now under treatment.
Metropolitan Parishes and Districts—*cont.*				
Southwark, St. George's Par	62	0	5	56
Southwark, St. Olave's Parish	38 diar.	1 ch. 1 diar.	37 diar.	0
Southwark, St. Saviour's Par.	1 ch. 188 diar.	1 ch.	188 diar.	0
Strand District	1 ch. 397 diar.	1	No Return.	
Wandsworth District	8 ch. 331 diar.	2 ch.	5 ch. 328 diar.	1 ch. 60 diar.
West London Union	48	1	36	13
Westminster District	2 ch. 20 ch. diar. 107 diar.	0	15 ch. diar. 87 diar.	2 ch. 5 ch diar. 20 diar.
Westminster, St. James' Par.	1 ch. 215 diar.	1 ch.	184 diar.	31
Whitechapel District	355	4	No Return.	
Narberth Union	104	7	83	14
Neath Union	368	36	215	117
Newbury Union	237	0	237	0
Newcastle Emlyn Union	2	1	0	1
Newton Abbot Union	2 ch. 4 ch. diar. 69 diar.	2 ch. 1 ch. diar.	50 diar.	3 ch. diar. 24 diar.
Ongar Union	7 diar.	0	0	2
Ormskirk Union	76	6	52	24
Oswestry Union	4	1	2	1
Pembroke Union	91	7	48	36
Pocklington Union	12 ch. 13 diar.	6 ch. 1 diar.	0	6 ch. 18 diar.
Pontypridd Union	5 ch. 6 ch. diar. 44 diar.	2 ch. 1 ch. diar.	1 ch. 38 diar.	3 ch. 5 ch. diar. 25 diar.
Portsea Union	812	6	646	235
Prescot Union	22 diar.	2 ch.	21 diar.	1 diar.
Rochford Union	36	1	29	12
St. Thomas Union (close to Exeter)	12 ch. 60 diar.	12	2 ch. 40 diar.	5 ch. 41 diar.
Salford Union	475	4	414	232
Sevenoaks Union	2	2	0	1
Sheppey Union	1	0	1	0
Southampton (Town)	7 ch. 64 diar.	4 ch. 6 diar.	No return.	
Stourbridge Union	10	6	0	7
Swansea Union	580	69	420	189
Thanet (I. of) Union	62	5	65	34
Thetford Union	14	0	15	9
Thorne Union	3 ch. 21 diar.	0	22	2
Totnes Union	50	16	6	32
Warrington Union	21	0	19	2
Wellington Union (Somerset)	4	0	12	4
West Ham Union	5 ch. 30 diar.	2 ch.	12 ch. 18 diar.	3 ch. 28 diar.
Wirral Union	28	17	3	15
Wortley Union	10	8	2	"Notknown."

APPENDIX.

No. 7.
On various Outbreaks of Cholera.

a. Among Foreigners in the Mersey.

No. 7.—REPORTS on various OUTBREAKS of CHOLERA, with particular reference to the SANITARY Circumstances under which they occurred.

a. By Dr. BUCHANAN (May 19), on imputed CHOLERA among Emigrating Foreigners in the Mersey.

I HAVE the honour to report to you the following as to the condition of the emigrants who have been removed from the "Helvetia," and as to the measures which I have taken in pursuance of instructions given me on the 16th instant.

I found that up to the 15th instant 32 of the emigrants had died of cholera, viz., four in the workhouse (exclusive of three recently arrived foreigners who had died there without having been in the "Helvetia"), 20 in the "Jessie Munn," and eight in the depôt at Birkenhead. The remainder of the 925 emigrants had been thus disposed of—250 or thereabouts were in the Birkenhead depôt, and of these 11 were ill of cholera; 20 remained on board the "Jessie Munn," most of them being convalescent from cholera, but some being persons under suspicion only of the disease; 25 remained in the "Warcloud," having also been under suspicion; about 40 were in the Liverpool workhouse, of whom 11 were suffering under cholera or were convalescent from the disease, and the remainder were under observation; and the balance of the 925, viz., about 558 persons, should have been in warehouses at Bankhall, Bootle, all of them healthy; some of the last-mentioned people, however, were known to have gone away from the warehouses into Liverpool, where they could not be traced.

The people at Birkenhead were all foreigners, mostly families, and the sickness among them had been in people of various nationalities, but with a preponderance of those who came through Rotterdam. The people at Bankhall comprised 227 foreigners, most of them single men, and the remainder were British subjects. Those who had escaped into Liverpool were chiefly Irish. A few persons of various nations had fallen ill of cholera among the people at these warehouses, and had been removed case by case, as soon as they occurred, to the Liverpool workhouse. In the course of Wednesday, the 16th, the 25 persons who had been under observation in the "Warcloud" were transferred to Bankhall.

In the Birkenhead depôt the people were provided with all necessaries except proper changes of linen, and these were being distributed from charitable funds collected by two German clergymen of the neighbourhood. Sufficient supervision to preserve order existed, but there was an uncertainty and conflicting authority in dealing with the people. Thus on my arrival at the depôt at noon on Thursday, the 17th, I found no dinner provided, and an arrangement pending—it was difficult to fix on any person the responsibility of having made it—to transfer all the people from the depôt to the Baknhall warehouses. Again, there was no sufficient isolation of the sick people, nor of the persons whose relation to the sick brought them under suspicion. All were under the same roof, the cholera cases in a "hospital" only partially separated from the sleeping places of the healthy.

In the Bankhall warehouses provision had been extemporised by the select vestry of Liverpool for the accommodation of the people placed there, and they had been supplied with changes of linen and other necessaries. The deficiencies of the place consisted in a want of lavatories, and in the circumstance that the classification of the people did not meet their own views, though it appeared sufficient

for the purposes of decency and safety. Another condition of this lodgment at Bankhall was, that the people were allowed to wander into Liverpool and Bootle at their will, and some of them did not return. On the evening of the 18th only 484 persons slept here, leaving about 70 unaccounted for. These warehouses, though fairly answering their purpose with their present numbers, could not have been properly allowed to hold the additional number which it was proposed to transfer them from Birkenhead. At Bankhall an ambulance was kept, ready horsed, by the guardians of Liverpool parish, and a medical man and interpreter were on the watch for cases of early illness, which were easily transferred to the workhouse.

At the Liverpool workhouse cholera cases were being treated in two floors of the fever hospital, which were so managed as to be satisfactorily isolated, and the people under observation were in a wholly isolated shed.

In all places adequate medical attendance and competent nursing appeared to be afforded. Particularly I must take leave to report that, under most trying circumstances in the "Jessie Munn," the nursing has been done with exemplary devotedness and efficiency.

The dates of the deaths from cholera (including ALL that have occurred on the river or on either shore) have been as follows:—

May 2	2	May 10	7	
3	1	11	3	with 6 added in the four days.
4	0	12	3	
5	0	13	2	
6	1	14	1	
7	1	15	2	
8	2	16	1	
9	4	17	1	

Only one fresh case of cholera was known to have occurred among any of the emigrants or their attendants during the whole of yesterday or the day before (May 17, 18), and that was in a foreigner taken on the 17th from Bankhall to the workhouse with a slight attack. Moreover, the severity of recent attacks has been less than at the beginning of the outbreak, and in the persons attacked recoveries are now more frequent than deaths.

No single authenticated case of cholera is known to have occurred in Liverpool or Birkenhead, except among persons who had had to do with the "Helvetia" and among other foreign emigrants waiting for the means of transit. One or two of such that were fatal are comprised in the foregoing list.

Beyond advising such additions to the Bankhall accommodation as appeared requisite, I did not interfere in any way with the arrangements on the Liverpool side of the Mersey; probably no stricter isolation of the people would have been practicable, and at any rate, if harm should come of their scattering, the chief of that harm must be already done; while, on balancing the existing conditions against those that might conceivably be enforced in the way of restriction, I could not certainly have said that the advantages would be positively on the side of more seclusion.

The conditions at Birkenhead appeared susceptible, however, of much improvement. The want of responsible authority was clear, and the desirability of separating the sick and healthy was agreed on at all hands. The Disease Prevention Act having been put in force, the Board of Guardians became empowered to take action of precisely the kind that was desirable. Accordingly, after seeing that the immediate

Appendix.

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On various Outbreaks of Cholera.

a. Among Foreigners in the Mersey.

wants of the emigrants in the depôt were met, and after countermanding the conveyance of them to Bankhall, I set to work to determine how in practice the required ends could best be attained, and having satisfied myself on all necessary points, I saw the vice-chairman of the Board of Guardians, who undertook (as I stated to you in my telegram) to act immediately upon my advice. At a meeting of the Board yesterday (18th May), resolutions were passed confirmatory of this action, and by the present time the healthy people, taken charge of by the Guardians under the Diseases Prevention Act, have been removed to the new building at Tranmere, where they will have advantages greater than could ever have been thought of in such an emergency, and from whence any who fall sick will be returned to the depôt. The Guardians have also undertaken the management of the sick who remain in the depôt continuing as far as possible the services of the present staff of officers. I append copies of my letters to the Birkenhead Board of Guardians and of their resolutions thereon.

I have further to report that no clear way has yet appeared of acting upon that instruction of their Lordships which authorized the expenditure of Government funds for the purpose of expediting the emigration of the healthy; nor have I definitively undertaken any expenditure (as by another portion of their Lordships' instructions I was empowered to do) for the comfort or safety of the emigrants, inasmuch as funds appeared to be readily forthcoming from local sources for all that was needed. But the permission of their Lordship's enabled me to direct without hesitation that certain immediate wants should be provided, and if the arrangements that have been made had broken down, would have enabled me in other ways to act for the advantage of the emigrants.

In conclusion, I have to acknowledge the ready assistance that has been afforded me by local authorities and their officers, by the Poor Law Inspector of the district, and by the officers of the Emigration Commissioners.

b. In Southampton.

b. By Professor Parkes, on Cholera in Southampton.

Outbreak of cholera in Southampton.

I reported last year to the medical officer to the Privy Council the particulars of the outbreak of cholera in Southampton in the autumn of 1865. I have now to report more briefly on the outbreak which occurred in the same town in July and August 1866, and which is, I believe, in many respects, a very instructive one.

Commencement of the outbreak.

The last case of cholera in 1865 occurred on the 4th November, and from that date till June 1866 there was not a single case, either registered in the death returns or reported by any medical practitioner. The deaths from diarrhœa were also very few; in January 1866, there was no death; in February, March, and April, only one in each month; in May only two; and in June three, of which one was certainly cholera. In July, August, and September, there was an increase of deaths from diarrhœa, chiefly owing to the registration of deaths from cholera under the heading of diarrhœa. It is doubtful whether apart from cholera there was any increase of fatal diarrhœa properly so called, during the period of the cholera outburst.

Number of deaths.

The following are the number of deaths registered in Southampton from cholera and diarrhœa, as extracted from the report of the sanitary committee of the Board of Health (page 7), from the 1st of June to the 31st October:—

	Registered Deaths.	
	Cholera.	Diarrhœa.
Week ending June 4 - - - -	–	–
" " 11 - - - -	–	–
" " 18 - - - -	1	1
" " 25 - - - -	–	2
" July 2 - - - -	–	3
" " 9 - - - -	1	2
" " 16 - - - -	16	7
" " 23 - - - -	27	2
" " 30 - - - -	21	2
" August 6 - - - -	15	4
" " 13 - - - -	4	3
" " 20 - - - -	6	1
" " 27 - - - -	1	3
" Sept. 3 - - - -	1	6
" " 10 - - - -	1	6
" " 17 - - - -	4	1
" " 24 - - - -	1	3
" Oct. 1 - - - -	–	–
" " 8 - - - -	1	2
" " 15 - - - -	1	–
" " 22 - - - -	–	–
" " 29 - - - -	–	–
Up to and including 31 - - - -	–	–
	101	48

It is impossible to be quite sure how many of the deaths registered as diarrhœa were really from cholera; I believe a large proportion of them, but it is now hopeless to attempt a precise statement.

Number of cases.

The total number of cases of cholera is stated by the local board of health to have been 320, but I feel uncertain whether this is correct.

Mode of origin.

The determination of the exact number, is, however, a matter of little consequence; it is of much more importance to find out what caused the re-appearance of the disease.

In the spring of 1866, some apprehension of cholera was caused by the constant arrival of steamers carrying German emigrants from infected ports. On reaching Southampton the emigrants were always allowed to land, and often remained the whole night in the town; and it was feared that in this way cholera might very readily be introduced. But the state of the law at the time rendered it impossible to prevent the landing of those people, although their doing so brought great risk to the town without any adequate benefit.

Happily, however, these fears proved unfounded; at least there is no evidence that any emigrant vessel introduced the disease, and it so happened that no emigrant vessel leaving Southampton for America suffered from cholera on the voyage.

Case of the "Poonah."

On the 10th of June 1866, the Peninsular and Oriental Steam Ship "Poonah," arrived from Alexandria, Malta, and Gibraltar, having on the preceding day lost a man from cholera. The incidents connected with this voyage and the probability that the disease was thus introduced into Southampton are so important, that I shall narrate them with great care.

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On various Outbreaks of Cholera.

b. In Southampton.

I derived my information from the official papers, and from information given me by Dr. Chapman, the surgeon of the vessel, and by a fireman on board, who gave me very careful and circumstantial evidence.

On the voyage home from Alexandria both crew and passengers enjoyed perfect health until two days before arriving at Southampton, when a man died from cholera, and several others became ill with severe diarrhœa. The cause of this outbreak was attributed to the use of foul water. Water was taken in at Gibraltar, and the tank containing it was opened on Tuesday, June 5th. According to the statement of the medical superintendent of the Peninsular and Oriental service, this water might be used by passengers and crew ; Dr. Chapman told me it might be used by the firemen and crew, about 60 persons in all, but not by the passengers ; the fireman told me that he thought only the firemen used it, but this was not certain. It is, however, quite clear that the firemen used more of it than the other men, as on account of their occupation they always drink much more. The choleraic or diarrhœal affection occurred, with one exception, entirely among the firemen.

The water smelt and tasted very foul from the moment it was used.

On Friday, the 8th June, a fireman named Joseph Bachelor went on deck and drank a very large quantity of this water ; early the next morning he was taken ill with violent purging, vomiting, and cramps, followed by coldness and pulselessness, and died in nine hours. He was buried at sea on Saturday.

On the same day (Saturday, June 9th) six or seven other firemen, and on the following day three or four more were affected with violent purging, and some with vomiting as well ; none of these men reported themselves to Dr. Chapman as they were afraid of being detained on board. My informant was taken ill on Saturday; he had great purging of watery fluid, with cramps in the stomach but not in the limbs ; he had no vomiting ; his eyes were sunken with dark areolæ ; and he passed no urine for three days. The diarrhœa (15 to 20 stools per diem) lasted for four days. In this man's watch there were six other men all affected in the same way, and several others were ill. All the men who were ill had drank the water, but it was not certain that all who drank the water became ill. No passengers were attacked, and only one man of the crew.

All these sick men landed in Southampton on Sunday and Monday (June 10th and 11th), and dispersed over the town ; they were seen by several medical men who diagnosed the disease as the severest "choloraic diarrhœa." Only one of them died, and most of them in spite of the diarrhœa continued at work. All of them, even before landing, attributed their disease to the foul water.

I think it may be concluded without hesitation that this severe diarrhœa outbreak was owing to the water. The freedom from any affection of the kind during the voyage, the ascertained foulness of the water, the fact that those who drank most of it (the firemen) were chiefly affected, the number attacked, and the suddenness of the outbreak, give sufficient evidence. Cholera did not exist at the time at Malta or Gibraltar, and I believe not at Alexandria.

So far, however, in spite of the death on board with every symptom of cholera, it might be contended that this diarrhœa was not true cholera, but a case of the highest interest sets the question at rest. I derive the following account from the widow of one of the firemen of the "Poonah."

Edward Palmer, a fireman in the same watch as Bachelor, the man who died, went to his home, 106, Bevoir Street, a very clean airy situation on Sunday, June 10th. Either on that day or on Monday he

was attacked with diarrhœa, which was very bad on Monday, Tuesday, and Wednesday. He slept in an airy room with his wife and child; he generally used the closet outside, but once or twice used the utensil in the room, which, however, the widow informed me he emptied immediately. On Wednesday, June 13th, his child (a boy aged about three years, and previously in perfect health) was suddenly taken ill at 10 a.m. with violent vomiting, purging, and cramps; he soon became very cold and died at 4 p.m. The child was seen by several medical men, who were satisfied the case was one of cholera. On the Thursday Palmer himself became worse; he was very sick; had cramps; the eyes were sunken; the hands shrivelled; he passed no urine; and died on Friday, June 15th.

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b. In Southampton.

No other case occurred in the house or neighbourhood, and, as I ascertained by a careful inspection, there was no possible local cause to account for the child's death.

This incident proves that the disease caused by the foul water was really cholera, and that it was communicated. Moreover, the disease was given by the father to the child while it was yet in the so-called diarrhœal stage, and before the distinctive symptoms of cholera had come on.

There were were only five people in this house, viz., Palmer, his wife and child, and two other persons who lived on the ground floor. No subsequent case occurred either at this time or afterwards in this house or neighbourhood. The house is drained into the town sewer, and is supplied with water from the town reservoir on the continuous system.

Although there was no other death there can, I conceive, be no doubt that all the men who landed from the "Poonah" with so-called diarrhœa suffered from the same disease as Batchelor died of on board, and Palmer and his child on shore, and that this disease was cholera. This being admitted, there can also be no question that the dejecta of cholera in large quantities must have passed from 8 or 10 persons into the sewers of the town.

Was the cholera thus introduced into Southampton?

Before considering this point, I may perhaps be permitted to say a few words on the origin and composition of the tank water which caused the disease in the firemen.

Water from the "Poonah."

A few days after the "Poonah" came in, some of this tank water was sent to me. Its composition was on the 18th June 1866:—

	Grains per gallon.
Mineral solids - - - -	35·42
Volatile solids (by incineration) - -	5·74
Total solids - - -	41·16
Total hardness (Clark's scale) - -	15°·75
Permanent hardness - - -	9°·8
Removeable " - - - -	5°·95

One litre contained oxidisable matter enough to destroy 19 milligrammes of permanganate of potassium. The amount of nitrites, nitrates, and phosphates was very large. There was no sulphuretted hydrogen at this time, although this subsequently formed. There was a good deal of chloride of sodium, sulphates and carbonates of lime and magnesia. There could be no doubt of its contamination with sewage.

Subsequently some of this same tank water was sent to Professor Taylor, of Guy's Hospital, who found it to have the following composition:—

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b. In Southampton.

Dr. Taylor's analysis, dated August 7th, 1866.

	Grains per gallon.
Mineral substances - - -	37·6
Organic and volatile matter - -	5·4
Total - - -	43·0
Hardness (Clark's scale) - - -	15°

The separate ingredients are not mentioned, but the water is said to contain carbonate of lime and magnesia, chloride of sodium, sulphate of lime, and soluble alkalies. It also contained sulphuretted hydrogen; when distilled, the residue had lost the smell of sulphuretted hydrogen, but retained an offensive odour resembling decomposed sewage matter.

Water from Gibraltar.

This water was known to have been shipped at Gibraltar, and was supposed to have come from one of the North Front Jetty wells,* from which the merchant vessels are generally supplied. The Peninsular and Oriental Company sent out to Gibraltar and obtained, on July 19th, some of this water, which they sent to Professor Miller, of King's College, to analyse. The following was his report :—

	Grains per gallon.
Mineral solids - - - -	43·48
Volatile - - - - -	1·12
	44·60
Total hardness (Clark's scale) - -	27°·3
Permanent hardness - - -	10°·5

The separate ingredients were :—

Carbonate of lime - - -	7·67
Carbonate of magnesia - - -	7·78
Nitrate of magnesia - - -	5·42
Sulphate of soda - - - -	10·52
Chloride of sodium and a little chloride of potassium - - - -	12·09
Organic matter - - - -	1·12
	44·60

Some water taken from the three North Front Jetty wells by order of the War Office was also sent direct from Gibraltar to Mr. Abel, and the following is his analysis, dated October 13th, 1866 :—

——	No. 1 Well.	No. 2 Well.	No. 3 Well.
	Grains per gallon.	Grains per gallon.	Grains per gallon.
Carbonate of lime -	11·14	9·64	10·94
Sulphate of lime - -	4·08	8·16	9·20
Nitrate of lime - -	1·75	1·75	2·00
Carbonate of magnesia -	6·30	5·77	7·87
Chloride of sodium -	10·63	13·10	14·16
Organic matter - -	1·50	2·00	2·10
Total solids -	35·40	40·42	46·27
Hardness (Clark's scale) -	23°	26°	30°

* There are three wells known by the name of the North Front Jetty wells; all of them are somewhat under the influence of the tide, especially the one nearest the sea.

While there is a good deal of agreement in the analyses by Professor Taylor and by me, which were undoubtedly of the same water taken (at different times) from the tank, there is a great discrepancy in the other analyses of water taken from the wells at Gibraltar at different times.

Up to the time of seeing Dr. Miller's analysis, I had felt no doubt of the origin of the "Poonah" tank water from the North Front Jetty well, but on learning Dr. Miller's result, it seemed to me hardly possible to account for such a discrepancy between the analyses of Dr. Taylor's and mine on the one hand, and Dr. Miller's on the other, by any change in the water of the well, between the periods when it was drawn for the "Poonah," and for Dr. Miller's analysis.

The doubt raised in my mind was strengthened by another circumstance.

I had written to Dr. Rutherford, Deputy Inspector General of Hospitals, stationed at Gibraltar, to inquire how the North Front Jetty well could have become contaminated with diarrhœal or choleraic discharges, for that the common water of the well, bad as it is, could produce such a disease as that of the firemen, seemed in the highest degree improbable.

Dr. Rutherford after giving full information of the position of the jetty wells, and of the strata furnishing the water, thus answered my other questions :—

"1. I really do not see how the well in question could have been contaminated with common sewage matter in May or June 1866, seeing there are no sewers in its neighbourhood, unless, indeed, such impurity was derived from the gardens at some considerable distance, or from the sea, either contingency improbable.

"2. I consider it impossible that diarrhœal or choleraic discharges could have found entrance into the well at the time specified, as since the cessation of cholera in October 1865, neither diarrhœa or cholera existed in or about the garrison. Indeed in May or June 1866, and for months before and after, everybody near these wells enjoyed perfect health as far as bowel complaints are concerned at all events."

These facts coupled with the discrepancy of the chemical analyses made me anxious to have some further proof that the "Poonah" water really came from one of the North Front Jetty wells.

I requested several persons to give me information, and eventually Dr. Chapman, of the "Poonah," was able to learn the following for me. Merchant vessels are generally supplied from the North Front Jetty wells, but on the occasion in question the "Poonah" was decidedly not watered from these wells. Dr. Chapman could not learn precisely whence the water was drawn, but found that the most probable source was from a well situated near to the Jews burying ground.

Dr. Rutherford has informed me that this well is 250 yards from the burying ground, and that in his opinion soakage into it from the graves is impossible. I have been able to get no further information.

I fear, indeed, that the source of the tank water of the "Poonah," and the nature of its contamination, will now never be discovered. It may be a question whether the water was taken from Gibraltar at all.

However, the facts remain, viz., that whatever its source, the water was very foul, and no doubt from sewage; that at least eight, and probably 10 or 12 men who drank it, were violently ill with cholera or severe choleraic diarrhœa; that one of these men died on board after nine hours illness, and another on shore after several days illness, and after giving cholera to his child; and that several other men (7 or 10) suffered for several days in Southampton after landing with very severe choleraic diarrhœa.

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b. In Southampton.

Introduction into Southampton.

The question now is, did these men introduce cholera into Southampton?

Four cases, in addition to the "Poonah" cases, were reported as occurring on the following dates in inhabitants of Southampton: one case on June 12th; one on June 15th; two on July 6th.

Of these, I am quite satisfied that the supposed case on June 12th and one of the cases on July 6th were not cases of cholera at all. I have also great doubts about the other two (15th June and 6th July), but the gentleman who attended them, and for whose opinion I have an unfeigned respect, is satisfied that they were genuine cases. If so, no direct communication can be traced between them and the "Poonah" cases, but it is impossible to prove the negative.

Whatever may be the truth as regards these two cases, in the early part of July, three weeks or a month after the arrival of the "Poonah," the outbreak decidedly commenced. On the 6th there was one case; on the 11th there was one case; on the following day another; and on the 13th no less than nine; there were about the same number on the 14th, and 10 on the 15th and 16th, but the numbers are not precisely known, and there may have been more before the 13th than I have stated. Up to the evening of July 17th probably no less than 35 to 37 deaths had occurred. On the following days the numbers were not quite so great, and on the 24th July the cases were greatly diminishing in some of the worst districts. By the 4th or 5th August the outbreak was virtually over, though a few cases occurred through the rest of August. Even in September seven deaths were registered from cholera, and two in October.

The return copied at a previous page from the sanitary committee's report does not properly show the extreme rapidity of the spread in the first instance and the rapid decline, as the dates are taken from the dates of registration of the deaths and not from the dates of attack.

What then was the cause of this sudden outburst?

As far as locality went it was confined to the low and unhealthy parts of the town, but was scattered through them and was not extremely bad in any one spot. All the upper part of the town was free, and the surrounding suburbs and villages remained unaffected. The following are the conclusions I have arrived at after carefully collecting and considering the evidence:—

I. Except the "Poonah," there is no traceable mode in which the disease could have been imported, though of course as cholera existed in so many parts of the continent with which Southampton is connected and in England, it is impossible to absolutely disprove another channel of importation.

II. If introduced by the "Poonah," it did not immediately spread from these cases as centres; one case (the child) can indeed be traced back, but the others had no obvious connexion; that is to say, the connecting link was not that of proximity.

III. Although manifestly caused in the "Poonah" by bad water, its subsequent outburst in Southampton was entirely unconnected with the drinking water.

Water of Southampton.

The whole of Southampton is supplied from a town reservoir; the supply is continuous; there are no cisterns. If the water was the cause, it must have affected the town generally; there are nearly 50,000 people in Southampton, and there were only about 320 cases of cholera scattered over nearly three months. It is impossible to suppose that 49,700 people who used the water could have escaped had the water been bad. At the end of July (when it is true the outbreak was subsiding), the water taken from districts where cholera was prevailing was analysed, the volatile solids were 1·4 grains per gallon; the mineral 15. There was no nitric, nitrous, or phosphoric acid, or any

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evidence of sewage; in fact, the water was of its ordinary composition. I believe we can entirely exclude the drinking water as a cause of the outburst.

IV. The disease was certainly worst in the most unhygienic parts of the town, but was not confined to these, for good houses in airy situations in the low part of the town suffered, and some of the worst localities remained free. I can only repeat what I have already stated in my former report, that unhygienic conditions of an ordinary kind can only be reckoned as localizing or intensifying causes, not as capable of originating the disease. If, indeed, cholera could have arisen from ordinary unhygienic conditions, it might have been expected in May or the beginning of June, for at that time the sewers in the low part of the town were being cleared out; the sewage matter was heaped on the banks, and was very fœtid, yet no cholera was caused, and the sewers had been closed, and the sewage matter removed before the cholera occurred.

V. I have referred in my former report to the very unsatisfactory nature of the explanation which is attempted to be given of such outbreaks, by referring them to peculiar atmospheric or unknown epidemic conditions. There was no evidence of such epidemic influence in any increased illness, diarrhœal or otherwise, before the outburst, and there was nothing unusual in the common meteorological conditions.

Causes of spread.

VI. I believe, however, that the outburst is capable of a satisfactory explanation, provided only the proviso be granted that the intestinal discharges of cholera are capable of propagating the disease at once, or at a certain period of decomposition. To make my explanation clear, however, I must enter into a little description of the sewerage of Southampton.

Almost all the town is sewered, but unfortunately on a bad principle, a very large network of sewers being provided towards the outlet, in order to act as a reservoir during certain periods of the tide. There is thus a great stagnancy during several hours in the day, and indeed at some periods it is probable that there is very little flow even for long periods. The ventilation is very imperfect, being provided for by gratings in the road, and as these give off offensive effluvia, they are continually stopped up with pieces of wood by the inhabitants of the neighbouring houses. The consequence is, that the gases are thrown back upon the houses, and force their way through the very imperfect traps.

The drainage from the western part of the town is raised by pumping, and is then discharged into the eastern sewers and passes to the outlet, after more or less detention in the eastern sewers.

Now, just before the outbreak of cholera there was this condition of things. Owing to the cleansing of the sewers the pumping at the regular station had been discontinued for some time; there had been more accumulation than usual in some of the sewers, partly from this cause, partly from a scarcity of water. The water mains were being altered to give a larger supply, and fresh machinery was being erected. During this time, in spite of the greatest exertions on the part of the water engineer, the supply, especially to the lower parts of the town, was insufficient; one of the difficulties of the continuous system was now felt. In the upper parts of the town, where the water was first received, an immense quantity was used, and (as the weather was dry) especially for watering gardens. The lower parts of the town suffered therefrom in a twofold way, from the actual lessened supply, and from the greater use on the part of their richer neighbours. As the rainfall was unfortunately small, there can be no doubt that the flow through

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the sewers was much slower even than usual, in fact, it may be questioned whether there was not almost complete stagnancy at the end of June and the beginning of July.

While this state of things was going on, on the 10th or 11th June the men landed from the "Pocnah," and some of them continued to suffer from choleraic diarrhœa for six or eight days, or nearly till the 20th June. All the copious discharges from eight or ten persons passed then into these sewers, western and eastern, which were almost clogged. Admitting that these decomposing discharges would produce the disease, this state of things was very ominous for Southampton, as it was clear that the insufficient ventilation would force the vapours or gases into every house with a bad trap. Independently of anything else, I believe that cholera would have broken out; but another circumstance occurred which seems to me to have been the immediate cause of the outbreak.

In the beginning of July the pumping of the western shore sewer into the outlet sewer was re-commenced. The pumping station is near the floating bridge in a tolerably good neighbourhood, but all round it are some of the lowlying parts of Southampton. The pumping is done by a steam engine and generally goes on day and night.

All the immense mass of sewage from the western sewers was raised and was then poured down an open conduit into the outlet sewer. Tons and tons of sewage were thus daily pumped up, and frothing and agitated by this churning were poured like a cataract down the open channel for some 8 or 9 feet. The effluvia disengaged from this quantity of seething sewage was overpowering. It spread all over the neighbourhood and was bitterly complained of in the adjacent houses. The effect, however, would not be confined to them; the cloud of effluvia thus thrown up must have extended far beyond the point where it was detectible by smell.

The occurrence of some early cases of cholera in clean airy houses near this pumping station was the first thing that called attention to it, and it was then found that diarrhœa was beginning to prevail in several of the adjacent houses. There was no local cause to account for these attacks except the great effluvia thus disengaged. Some cause having to be found for these choleraic and diarrhœal cases, and nothing being discoverable in the houses or in the water supply, it seems quite justifiable to attribute them to the organic substances sent out in enormous quantities into the atmosphere by this system of pumping; and if so, some of the more distant cases may be reasonably ascribed to the same cause.

Subsidence of the outbreak.

As soon as this was discovered means were taken to substitute a closed iron pipe for the open conduit, and carbolic acid was largely and constantly introduced at this point into the sewers. The alteration was not completed till late at night on the 18th July; on the 19th there was not the slightest disengagement of effluvia. As already said the number of cases of cholera were very numerous from the 13th up to the 17th or 18th of July; they then lessened, and on the 24th July it was evident that the worst was over.

To what cause could this rapid diminution be ascribed?

No doubt a great deal was being done in all sanitary ways, but the strongest impression was made on my mind that the principal cause of the outbreak had been the discharge from the pumping station into the air of fæcal effluvia from sewers into which cholera discharges had been largely introduced and retained, and that the rapid decline was owing to the removal of this cause of foulness of the air.

I do not, however, wish to state that all the cases were owing to this.

In some instances the houses were too far away from the pumping station, or the cases occurred too long after the defect was remedied, to be explained by the supposition of a long incubative period. In some of these cases the house traps were inefficient, and sewage gases found their way in, and this perhaps kept up the few scattered cases which continued in August and September.

On the whole this outbreak has certainly strengthened my conviction that the decomposing choleraic discharges will produce the disease, and that they will spread through the air as well as through the medium of water. In fact, in this outbreak we have instances, I believe, both of transmission by water and by air.

I believe then I have accounted for this sudden outbreak in as satisfactory a manner as can be done in these inquiries, and the more the points are considered, the coincidences as to time, of prevalence and decline with the peculiar conditions of the sewer arrangements, the impossibility of accounting for the attacks in other ways, the more will conviction be brought to the mind that the above explanation has every look of probability. Neither in this attack in Southampton, or in the former one, have I found any evidence in support of Pettenkofer's opinion that the discharges must pass into the ground and there decompose. They can decompose equally well in sewers. The conditions of soil and subsoil water mentioned by Pettenkofer are no doubt of importance in many cases, but they are obviously not essential.

Preventive measures.

It now only remains to state the preventive measures. They were instituted and carried on with great vigour by the sanitary committee, of which Mr. Stebbing was the indefatigable chairman, and by Dr. MacCormack, the officer of health. Dr. Wiblin, the superintendent of quarantine, gave as in the former outbreak the most valuable assistance, and so did all the parochial officers and other medical gentlemen. The greatest efforts were made to disinfect the discharges, and linen in the houses, and to disinfect the sewers. Carbolic acid was freely supplied to all houses, and was used also for watering the streets and pouring into the sewers. A suggestion of Professor Maclean's that all the inhabitants of the higher parts of the town should be requested to pour carbolic acid down their closets was also attempted to be carried out, so as to get the whole length of sewer impregnated with the acid. Infected clothing was burnt or otherwise purified, and limewashing, scavenging, house to house visitation, &c., were carried on with great energy. The average daily amount of carbolic acid used was about 20 gallons ; on one day, however, about 34 gallons were used. About 30 lbs. of chloride of lime were also daily used chiefly for utensils, linen, and sinks in houses.

In the course of my examination of the houses I was once more extremely struck with the very imperfect sewer traps in many of the small houses. The system of water sewerage has great advantages, but it has serious defects, and certainly in Southampton great improvements are necessary, both as regards ventilation and flow.

As regards treatment, I have unfortunately nothing to say. Subcutaneous injection of turpentine and of other substances was tried in some cases, with apparent benefit, but failed in others. Dr. Chapman's ice bag treatment to the spine was tried again, but did not gain in favour, although some of the medical men are still of opinion that it did good in some cases, and that it has not yet had a sufficiently good trial.

APPENDIX.

No. 7.
On various Outbreaks of Cholera.

c. In Irish Mail Steamers.

c. By Dr. Buchanan on Cholera in Irish Mail Steamers and at Holyhead.

1. *Concerning Cholera on the Mail Packets.*

Cholera Cases on Mail Boats.

The following is a list of the cases of Cholera and Choleraic Diarrhœa that have occurred on board the mail packets of the City of Dublin Company.

Name and Occupation.	Date of Attack.	Which Mail-boat.	Where landed.	Disease.	Result.	Date of Death.
1. John Hughes, seaman.	Sept. 29.	Munster -	Kingstown	Cholera* -	Death -	Sept. 30.
2. John Thomas, fireman.	Oct. 7. -	Munster -	Holyhead -	Cholera† -	Death -	Oct. 8.
3. — Lewis, stoker -	Oct. 8. -	Munster‡ -	Holyhead -	Cholera -	Death -	Oct. 13.
4. Robert Roberts, whitewasher. §	Oct. 12.	Munster -	Holyhead -	Choleraic diarrhœa.	Recovery -	—
5. Lewis Jones' son, under-steward.	Oct. 7. -	Ulster -	Holyhead -	Severe diarrhœa.	Convalescing.	—
6. Thomas Hughes, stoker.	Oct. 7. -	Ulster -	Holyhead -	Cholera -	Recovery -	—
7. Thomas Williams, steward.	Oct. 7. -	Connaught‖	Kingstown	Cholera -	Death -	Oct. 7.
8. Hugh Griffith, boatswain.¶	Oct. 8. -	Connaught	Holyhead -	Cholera -	Recovery -	—

* Subject of inquiry by Irish Poor Law Commissioners.
† Captain doubts whether disease was not "brain fever;" Doctor says "cholera."
‡ Temporarily employed from Oct. 3. to Oct. 6., when left ship.
§ Employed in disinfecting ship.
‖ Had belonged to Munster till the journey on which he fell ill.
¶ Had attended on Williams at Hospital.

The chief stress of the disease has fallen on the "Munster," and all the fatal cases, four in number, have been in persons connected with that vessel.

Causation.

As to the cause of Cholera on the mail vessels, the following data only exist : 1. There was no Cholera at Holyhead, and very little at Kingstown at the time when the first attack occurred on the "Munster." 2. The sanitary condition of all the packets was fully up to the usual condition of first class steamers. 3. The water supplied to all the steamers was from Juggy's well at Kingstown. This well is situated in a recess formed by three walls, ill lighted at night. It is approached by steps, over which the water rises to a varying height, being a foot or two higher in the morning than in the evening after the day's use. 4. A case of Cholera, one of the earliest in Kingstown, occurred on September 27 (two days before the first attack on the "Munster"), in a house situate about a quarter of a mile off Juggy's well and situate on rising ground above it.*

Water.

* Evidence of specific contamination of the well by cholera could not be obtained. Specimens of the water collected on Oct. 14th have been sent to Professor Miller for analysis. It will probably turn out that the water has the ordinary characters of that from surface wells; and additional impurities may have been directly introduced owing to its exposed situation and unprotected state. The suggestion, however, that the well receives sewage from the infirmary, the garden wall of which forms one of the walls of the well recess, is of no special moment. The infirmary could only affect the well by percolation for some distance of refuse fluids through the subsoil, in the same way as other houses equally near and standing on a higher level might affect it. At the time of the first attack on the "Munster," water from Juggy's well was taken each day to the ship, but up to that time there had been no cholera in the infirmary.
Professor Miller reported, October 26, "The water was clear and bright and free "from offensive smell or taste. It is a hard water, and though it softens considerably "on boiling, yet after boiling it still remains hard. The quantity of recent organic

Precautionary measures have been employed to all three of the mail packets. The "Munster" was laid up in the course of the week Oct. 7-13th; every compartment was disinfected with chlorine and whitewashed; the wood-work of the forecastle and of other parts was washed with disinfectants, and wherever it could not otherwise be satisfactorily dealt with, it was pulled down and replaced by new. The bilges were pumped out, with free use of disinfectants. The water tanks were emptied and fresh water procured from the best available source at Holyhead. On the Connaught the same measures were adopted, but the precaution of changing the water had not been taken. The "Ulster" is, at the present date, laid up, and is undergoing thorough purification.

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Precautions.

Since October 7th, the only fresh case of choleraic nature that has occurred in connexion with these vessels has been the whitewasher, whose name stands fourth in the tabular list. At the present time, October 16th, the ships appear to be in a perfectly safe condition.

The water of the Connaught has now been changed. The supply of all the vessels will be henceforth got from Holyhead. The new water supply of that town is just ready. It is derived from the mountain, and is of perfectly good quality.

2. *Concerning Cholera at Holyhead.*

Cholera at Holyhead.

For the past three weeks there has been much diarrhœa about Holyhead. A good deal of bilious diarrhœa had occurred through the summer, but this had subsided before September. The recent form of diarrhœa has appeared to be of a different and severer kind.

It will be seen in the first part of this report that on October 7th and 8th, several cholera cases were introduced into Holyhead from the mail packets. Besides such imported cases, it is probable that a few cases of cholera had occurred in the town before October 11th, and one of them fatal. But on and soon after that day a number of cholera cases made their appearance almost simultaneously in various parts of Holyhead and its suburbs. They appeared unconnected with each other and in only one or two cases seemed directly traceable to communication with persons brought from the ships. Since this date there have been three or four deaths, and several persons are still ill. A few particulars of each case are appended :—

" matter is but small; the amount of ammonia also is inconsiderable; but the " quantity of nitrates, though not excessive, show drainage from a soil impregnated " with decaying organic matter of animal origin.

" Nothing in the analysis of the water would lead me to suppose that it could be " *injuriously* impregnated with such matter. It is not a water that I should recom- " mend as a source of domestic supply on account of its hardness. The salts which it " contains are carbonates and sulphates of lime and magnesia and alkaline chlorides.

" I subjoin the details of the analysis :—

" Hardness before boiling (Clark's scale)		35°·7
" Hardness after boiling 1 hour		20°·0
" Specific gravity		1000·76
" Solids in solution in grains per imperial gallon		53·60
" Consisting of	Fixed salts	53·20
	Volatile and combustible matter	0·40
" Ammonia		0·015
" Nitric acid		4·55 "

After cholera had occurred, Capt. Rogers, of the "Munster," suspecting the water, ordered all used for drinking purposes to be boiled. He reports the case of a seaman, Parry, who, on Oct. 3rd, drank some of the unboiled water in violation of orders, and who was soon after seized with diarrhœa, which the captain and himself imputed to the water. His attack was transient and not severe.

HOLYHEAD Cholera and Choleraic Diarrhœa in addition to Cases on Boats.

Case.	Date of Attack.	Apparent cause.	Disease.	Result.
1. Boy at Millbank -	Beginning of October.	Believed to have been	Cholera	Death.*
2. Jones, landlord of public house.	Oct. 6	Unknown	Cholera	Recovery.†
3. Girl at Millbank -	Oct. 6	Vicinity to previous case 1. (?)	Cholera	Recovery.
4. Woman at Llangoch	Oct. 12	Nursing Lewis from "Munster."	Cholera	Death, Oct. 12.
5. Woman in Baptist Chapel Street.	Oct. 11	Unknown	Cholera	Death, Oct. 12.
6. John Jones's wife -	Oct. 12	Unknown.	Cholera	Convalescing, Oct. 16.
7. Emma Owen - -	Oct. 12	Unknown.	Choleraic diarrhœa.	Recovery.
8. Emma Roberts' daughter.	Oct. 12	Unknown.	Cholera	Still doubtful.
9. Lady under Dr. Price (well-to-do.)	Oct. 12	Unknown.	Cholera	Death, Oct. 13.‡
10. Case rumoured to have been attacked and died on Oct. 15.			No authentic information.	

* Case only thought much of when girl afterwards attacked.
† Previous diarrhœa two days.
‡ Had previous diarrhœa some days.

Want of action by guardians.

Upon the issue of the Order of Council of July 20th, the Guardians held no preliminary meeting and took no steps whatever. On October 8th the Chairman of the Local Board of Health, the Honourable W. O. Stanley, M.P., wrote to the Board of Guardians pointing out their responsibilities under the order; and on October 10th, Dr. Walthew, Parochial Medical Officer, also wrote to the guardians for instructions as to how he should deal with the cases of cholera that were in the town. No reply has been made to these communications; the Board of Guardians has taken on action, and has no intention of taking any action under the order.* Their next meeting will be held on Tuesday October 23rd.

Cholera cases have been dealt with as cases of any other illness would be, and no special facilities have been afforded or precautions taken. The Local Board have however, herein acting with an authority conferred by the Order of Council, not on them, but upon the guardians, obtained from the harbour master a house in an isolated situation, to which they have removed the family of a man who died of cholera, and are making other arrangements with this and similar objects.

Incapacity of guardians.

Respecting the conduct of the guardians in neglecting altogether the Order of Council, it may save delay that I should state, that the guardians appear incapable of discharging the most elementary of their functions. In proof of this, firstly, I refer to an appended correspondence between the guardians and the Poor Law Board, from which it will appear that upon been pressed by the Poor Law Board to provide a workhouse for the reception of their infirm and sick poor the guardians reply that, if accommodation were required for a homeless pauper sick of an infectious disease, "there are respectable registered lodging-houses in the town "which in their opinion would be bound to receive such cases." And secondly, I refer to the fact, stated publicly at a meeting of the Local Board of Health, and explicitly repeated for my information, that the guardians of the Holyhead Union provide for young orphan girls, by placing them in a house which they know is a brothel, and which is only not registered as a common lodging-house in consideration of its use as a brothel.

* This statement was made by a guardian who was present at a meeting of the Local Board, and who was questioned in my presence by the chairman.

c. In Irish Mail Steamers.

Under these circumstances, I feel bound to submit that if any other authority can be formed for executing the Order in Council against cholera, the guardians should be at once relieved of a trust which they are manifestly incompetent as well as unwilling to discharge.

Sanitary action.

Action under the various sanitary laws has been taken in Holyhead, somewhat more vigorously for the last few months than usual, for previously these laws had been very ill administered. Latterly, however, and in great measure owing to the appointment of a new chairman, preparations are being made for real sanitary improvement in the town. Besides any action that the board may have recently taken, a real benefit to health has just been conferred on Holyhead, by the introduction into it of a new and pure water supply that will (it is intended) supersede the surface wells at present in use.

The actual sanitary state of Holyhead is about as bad as is possible, but there is not much overcrowding.

d. By Dr. Buchanan on Cholera at Pill, near Bristol.

d. Cholera at Pill.

In accordance with instructions, I visited the village of Pill, on the Avon, on the 18th and 19th November. I inquired into the sanitary condition of the place, and the action that had been taken under the Diseases Prevention Act, and offered advice to the committee of guardians of the Bedminster Union.

The village.

Pill lies on the sides of two hills, which slope to a stream in the valley between them. The houses are mostly in short rows, and have gardens on some open spaces in connexion with them. Among the gardens go two streamlets, which receive all manner of impurities, serving for the only sewers of the village.

The chief inhabitants of Pill, speaking as to numbers, are the Avon pilots who bring vessels up to Bristol. There are no well-to-do people, except the parson, the doctor, and the brewer. The cottages are much overcrowded, the family often occupying one bedroom, and letting off the other to single men as lodgers.

The privies of Pill consist either of a seat jutting over the edge of the river creek or the stream, or have the usual village arrangement of an open privy pit, great ponds of seething filth lying behind the privy. The vaulted cesspool is not in use.

The water supply of the village is procured from the streams—as it is alleged, for washing purposes only—at points where they appear less impure than elsewhere; and also from two pumps and one well which furnish the water for drinking. One of the pumps in the present summer instantly furnished chlorinated water upon the occasion of chloride of lime being thrown on a neighbouring muck heap. The other pump is half dry when the tide of the Avon is low, but furnishes water that is in good repute. The well is alongside the road, in a position that exposes it to contamination from surface filth and subsoil soakage.

Pill is wholly unpaved and intensely filthy. Human excrement, ash heaps, vegetable refuse, and every sort of dirt meet the eye at every turn.

Occurrence of cholera.

The first two or three cases of cholera in Pill occurred in some low-lying parts near the river creek; the first of all being in the landlady of a public house frequented by sailors. Shortly after cases occurred in some houses abutting on one of the streams, which was known to receive night-soil from houses on a higher level. The main outbreak of the disease was between November 4th and November 7th. A list of cases shows 47 attacks of cholera and choleraic diarrhœa, with 16 deaths occurring between October 21st and the date of inspection.

The chief stress of the disease has been on the lower levels near the

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d. At Pill.

main stream, and in some rows every house was affected. "Under the Banks," alongside the river creek, was the row of houses that suffered most; three or four people were attacked in a house. The same locality was the scene of greatest prevalence also in 1849.

Action under Order of Council. by the "Vestry."

On Saturday November 3rd, Mr. Lloyd, the parochial medical officer, informed Mr. Moore, the rector, that there had been two deaths that day from cholera. Mr. Moore conveyed this report to Mr. Mirehouse, one of t he two guardians who had been constituted by the board of the Bedminster Union the sanitary committee for Pill. Mr. Mirehouse required Mr. Lloyd's statement to be authenticated by Dr. Budd of Clifton, who accordingly visited the place on Sunday evening, and saw several cases of cholera that had freshly broken out on that day, November 4th. Up to that time there had been no epidemic diarrhœa in the village.

A meeting of the "Vestry" of Pill, was at once summoned, and met on November 5th, when Dr. Budd, and Dr. Tibbetts, of Bristol, were present. The vestry appointed Dr. Tibbetts to be their medical adviser, and proceeded to carry out the provisions of the Order in Council, of July 20th. They acted thus under the belief that they were a legally constituted sanitary committee. Dr. Tibbetts had just had experience of the same sort of work in the Bristol Union.

Dr. Tibbetts brought with him a supply of disinfectants, two sanitary inspectors, and two nurses from Bristol (afterwards increased to five), and set to work energetically and thoroughly to carry out the regulations of Council, reporting from day to day to the vestry. He disinfected in a very perfect way every privy pit and collection of filth, beginning with the houses were cholera existed, and extending his operations all over the village. He established two dispensaries, and issued handbills telling people where to get diarrhœa medicines. Leaving the actual care of cases to Dr. Lloyd, he provided nurses, bedding, and all necessary comforts, saw to disinfection and destruction of infected clothes, and carried out arrangements for the speedy interment of the dead. Finding the boys of the village school suffering in considerable numbers (the girls comparatively escaped) from diarrhœa, he had all the children supplied with a good wholesome meal as well as with medicines daily. The water supply being wholly untrustworthy, the vestry, acting through Dr. Tibbetts, shut up the pump which yielded the obviously contaminated water, and employed carts to bring drinking water from a stream near Bristol, suppling it gratis to houses, and urging people to boil all water before drinking it. The vestry found a spring near the village issuing from the red sandstone rock at the rate of 72 gallons per minute; Dr. Herapath reported that this water was soft and free from organic matter, and on November 15th, the vestry began to lay down pipes for conveying this water into the village. Facilities were given to the vestry by Sir. W. Miles, on whose property the spring was found, by the engineer of the Bristol Water Company, who supplied pipes at cost price, and by the Railway Company which has works going on at Pill, and allowed its navvies to be employed in laying the pipes.

The Railway Company further gave the use of certain sheds for the reception of healthy persons from infected houses, and of a house for a depôt of food, clothing, &c. No place could be got for a hospital at any price. Funds for the immediate wants of the village were rapidly supplied through the generosity of people in Bristol and Clifton.

Action of authorities.

It appears that shortly after July 20th, a sanitary committee for Pill had been appointed, consisting of the two guardians of the parish, and Mr. Lloyd was nominated as their medical adviser. But the committee did nothing on the occurrence of the first cases of cholera, and on the occurrence of the disease in alarming proportions on

November 4th, they appear to have been merged in the "Vestry." Mr. Lloyd had never had any information of his appointment or of his duties in relation to the cholera. A sanitary inspector was also nominated who did nothing whatever, and as he only obstructed the action of the vestry, his services was dispensed with.

On November 13th, after 12 deaths had occurred and the operations of the "Vestry" had been going on for a week and more, the Bedminster board of guardians appointed a special sanitary committee of seven members to deal with cholera in Pill, under the Diseases Prevention Act, and the Order of Council.

This special sanitary committee first met for the transaction of business on November 16th, and they adopted certain portions of the action of the vestry, continuing the services of Dr. Tibbett, the inspectors, and the nurses, and authorizing the use of disinfectants. But they objected to the action that had been taken in superseding the old supply of water and in furnishing the village with new.

Further action.

On November 19th, I met the special sanitary committee, having previously been in communication with Rev. Mr. Moore, Sir William Miles, and the two medical men who were working the preventive and medical arrangements. The result of this interview was that the committee resolved, and the guardians of the Bedminster Union adopted the resolution, "to accept as their own action all action that had been "taken by the so-called Vestry in giving effect to the law and to the "Orders of Council," including the arrangement for a new supply of water to the village.

Effect of preventive, &c. measures.

I have only to add, that what was done by the vestry under Dr. Tibbett's advice had demonstrably the effect of extinguishing cholera in the village of Pill. The number of new cases began immediately to subside, and in the few outbreaks that occurred after the vestry got to work, the disease was always limited to the individual attacked, and did not spread even to others in the same house.

e. At Carnarvon.

e. By Dr. SEATON on CHOLERA at CARNARVON.

Cholera in Carnarvon.

The outbreak of cholera in Carnarvon is a most serious one. In a small town of less than 9,000 inhabitants (8,512 by the census of 1861) there have been within the last five weeks not less than 60 deaths from this disease, and at the date of my inquiry (Dec. 22–23) there was no diminution in the rate of mortality.

Commencement.

I am not able to trace the introduction of the disease. On Oct. 5 a death is recorded from "diarrhœa" of a child, aged two years, residing in Crown Street, but no suspicion of cholera was then entertained. On Oct. 17 the death is recorded of a child, aged four years, residing in Turf Square, from "cholera"; the next death (the first case that attracted general attention, or I believe was looked upon as a case of genuine epidemic cholera,) was that of Mr. Hugh Owen, of Castle Square, on Nov. 7. After this there was not, according to the testimony of the medical practitioners of the town, any case, and there was certainly no death, until Nov. 20, when a fatal case occurred in Segontium Terrace, followed by two more fatal cases the next day. From this date the disease has gone on incessantly.

Progress.

The mortality week by week (including five deaths entered as from diarrhœa or choleraic diarrhœa) has been as follows :—

Week ending Saturday, Nov. 24	-	-	6
" " Dec. 1	-	-	13
" " Dec. 8	-	-	9
" " Dec. 15	-	-	15
" " Dec. 22	-	-	17

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Up to the evening of the 21st above 400 cases of diarrhœa had been returned as treated successfully during this period by the district medical officers.

The disease has not been confined to any particular portion of the town, nor by any means limited to the very poorest people. The south-east corner of the town, however, has on the whole suffered as yet the most severely, one-third of the 60 deaths having occurred in Pool Street (a street on the road leading to Beddgelert) and three other streets on the slope between Pool Street and the Slate Quay on the river Seiont, viz., Wesley Street,* Baptist Street, and Chapel Street. In these streets there has been scarcely any, if any, house which has not had cases of cholera or diarrhœa. In the County Gaol, situate in a narrow street at the bottom of the town, on the south-west side of it (*i. e.*, towards the Menai Straits), there have been, in a population of 30 prisoners, six cases of cholera, 4 of them fatal; and three or four cases of diarrhœa. The disease has never, with the exception of one or two cases in the Llandwrog district, extended beyond the limits of the town. In the Union House, situate on the outskirts of the town, there have been no cases.

Bad sanitary state of the town.

In Carnarvon there exists every thing that should invite and give intensity to an outbreak of cholera, or any other infectious or epidemic disease:—great overcrowding, and bad house-construction; bad water supply; bad drainage; absence of privy accommodation; accumulation of surface nuisances.

Overcrowding.

1. *Overcrowding.*—This is of the worst kind; not merely are people crammed into houses too few to hold them, but the houses themselves are huddled together on a wholly insufficient space of ground. A large number of houses which I visited in company with the mayor and several of the leading inhabitants were without any windows or outlet at the back, and many of these were so placed (as in narrow courts) as to render free access of air in front impossible. H. Parry's Court was a striking example:—About 4½ feet wide, with narrow entrance, the houses (all without back outlet) being arranged on either side the court, the further end of which was closed and occupied by the privy. But in numerous houses having what are called back-premises these are so miserably confined as not to admit of proper ventilation. And the houses themselves are in many instances but miserable hovels, which ought to be closed as unfit for habitation.

It is quite certain that there is not in Carnarvon now the means of housing all the population, as human beings ought to be housed; but there is abundant building-space on the outskirts of the town, and it will be something gained out of the present calamity if it leads to energetic measures being taken for providing fit house-accommodation for the people.

Bad water supply.

2. *Water supply bad both in amount and quality.*—The deficiency of *quantity* will be understood when I state that a suggestion of mine for flushing the courts was pronounced at once beyond the bounds of practicability. The *quality* may be judged from the sources; one of the chief of these is the river Cadnant, a brook which, coming down from the hills, receives, I am informed, the drainage of many farms and of part of the populous settlement of Bethel, *after which*, but before it enters Carnarvon, two water companies, the Vaynol Estate Company and the Quellyn Company, take their chief supply from it and distribute it, mixed I believe in each case with some water from springs, to the principal streets and houses in the town. That the water thus supplied, such as it is, under-

* It deserves notice that there was an outbreak of fever in Wesley Street in the summer.

goes no proper filtration, is clear from the fact that it oftentimes comes into the houses turbid. The water of these companies is not laid on to the courts and poorer streets; and a very large portion of the inhabitants have to fetch all their water from springs, of which there are several in the town. But from the porous nature of the soil, and the position of the springs with regard to houses and privies, suspicion reasonably exists that they too are tainted. Specimens of the companies' waters and of the principal spring waters have been sent to Professor Miller for analysis.

I should state that the Town-Council are aware of the bad water-supply, and that a bill was obtained by them last session for bringing water of the purest quality, in quantity practically unlimited, into the town. Even the pipes have been purchased, but, if I did not misunderstand the mayor, the works are not begun. How far this delay has arisen from circumstances that might have been avoided I am unable to say, but I did not hesitate to express to the corporation my opinion that the gravest responsibility would be incurred by every day of unnecessary delay. Till this supply is got, not only have the people to go on drinking water which can scarcely be otherwise than dangerous, but the Town-Council, intending when it is obtained to compel owners to supply houses and courts with water-closets, suspend and have for some time suspended all action for compelling the provision of proper privy accommodation.

Defective drainage.

3. *Bad Drainage.*—Some of the streets have sewers (often untrapped), but a great, if not the greater, part of the town is without any provision for drainage. The Cadnant brook on entering the town becomes one of its chief sewers. Privies (where they exist) and drains are allowed to flow into it, and it is the great receptacle for the filth of all kinds which the privy-less people who dwell on its banks, or near it, choose to throw into it. At present, and with the heavy rainfall there has been, it is a rapid stream, but in summer and in dry weather it becomes a stinking ditch. In some parts of its course it is covered over and even built over; and in one house occupying this enviable position I noticed the ingenious contrivance (probably not limited to this house) of a trap-door in the floor for throwing filth directly into it and letting stenches directly up.

Scandalous want of privy accommodation.

4. *Defective Privy Accommodation.*—The want of proper accommodation of this kind is shocking. One privy to 12 houses was the allowance in Harry Parry's Court; but there are courts without any privy at all, and others (which amounts to the same thing) in which the so-called privy is in an utterly dilapidated and unusable condition. Hence excrements are thrown out on ashpits, on dunghills, on the floors of yards, or anywhere where they can be most readily disposed of. The influence which such a state of things would have on the propagation of cholera is obvious.

Surface filth.

5. *Surface Nuisances.* — These great defects of water-supply, drainage, and privy accommodation rendered all the more imperative a systematic inspection and daily removal of all *surface nuisances;* but, on the survey I made of the town, the abundance of filth everywhere met with testified to the inefficiency of the means adopted for this purpose. This subject had early in the spring excited the anxiety of the mayor, and two resident medical practitioners, Mr. Robert Jones and Mr. Watkin Roberts, had been requested to make a sanitary survey; on their excellent and practical report considerable action had been taken in the way of removal of dung, bones, ashpits, manure, swine, the cleansing of foul drains and privies, and the like; one of the main nuisances, however, the want of privies, being (for the reason I have

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Want of proper arrangements for cleansing, and of proper supervision.

mentioned) undealt with. But, unfortunately, after these cleansings in May, June, and July, things had been allowed to relapse till the deaths from cholera at the end of November, and a request of the Board of Guardians thereupon for more active cleansing, again roused the municipal authorities to action.

If a prompt assent to this request and excellent resolutions and orders would have cleansed a town, Carnarvon would long before my inspection have been clean; but, unfortunately, it had not been deemed necessary to see to the execution of the orders given, or even, I fear, to provide the necessary force for carrying them out. There was no inspector of nuisances* devoting to that work, as the circumstances of the town urgently require, his whole time; but this inspection had been made to devolve upon the borough-surveyor, an officer having abundance of other duties, and who besides, from illness, had been compelled to act by deputy; the scavenging force was inadequate, and though there existed, or was believed to exist, a sanitary committee of the Town-Council—an unwieldy body consisting of the whole corporation, minus those members who, being magistrates, might be called upon to adjudicate—it did not appear that since the resignation of the last and appointment of the present surveyor (in August last) they had ever been called together.

Before leaving Carnarvon I brought under notice of the mayor and corporation the course that should be pursued with regard to those defects that admitted of present remedy or alleviation. But so essential is it for the health of the town that works requiring time for their completion—works of water-supply, of drainage, and of privy or water-closet accommodation—should be set about *instantly* and prosecuted *zealously*, that I trust, that if any backwardness should be shown by the Local Board, means will be taken for calling into action the powers of "The Sanitary Act, 1866."

Action of the Board of Guardians in carrying out the Order in Council.

I proceed now to state the action taken by the Board of Guardians on the outbreak of cholera. No time appears to have been lost by them in taking measures for carrying out the provisions of the Order in Council, and most of those provisions have been executed with admirable promptitude and zeal. If in two respects—two respects unquestionably of the greatest consequence—the action of the board has fallen short of what the emergency required, it was certainly not from a lagging or a niggardly spirit, but rather for want of due advice as to the energy with which, under the circumstances, preventive measures were called for.

I premise that the ordinary division of the town for medical relief is into two districts, Mr. Foster being the medical officer of District 1, and Mr. Watkin Roberts of District 2.

Immediately on Mr. Owen's death (Nov. 7) Mr. John Williams, surgeon (partner to Mr. Watkin Roberts) was put in charge of the town, with two assistants, and instructions were given him to carry out everything required of medical men, or their assistants, appointed under the Order. After making inquiries which resulted in finding no other case of cholera, and not more than half-a-dozen cases of diarrhœa, Mr. Williams reported at the end of the week that their services were no longer requisite.

Upon the occurrence of the case in Segontium Terrace on Nov. 20, and of others about the same time, the poor law division of the town

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* By a letter received from the mayor to-day (Dec. 28) I learn that an inspector of nuisances will immediately be appointed, the advertisements being already issued and interim arrangements made.

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was had recourse to; but in addition to the services of the regular medical officers, Mr. Foster and Mr. Watkin Roberts, the partners of each, Mr. Jones and Mr. John Williams, were specially engaged. So that there were now two divisions, and four medical officers. On Nov. 24 a bill was extensively issued—placarded, and distributed also at houses —notifying these appointments, and informing the inhabitants that application might be made to these gentlemen for advice and attendance at any hour of the day or night. By Nov. 27 Messrs. Roberts and J. Williams were so overwhelmed with applications that they applied for further assistance, and immediately thereupon Mr. Edward Williams, a surgeon in the town, was engaged, and a part of Messrs. Roberts' and J. Williams' district separately assigned to him.

Subsequently to this, application was further made to the medical officers to ascertain if any more assistance was required by them to carry out the Order in Council ; and the clerk was informed that none such was needed. Although Mr. Edward Williams on his appointment went at first from house to house, making inquiries as to the existence of diarrhœa and cholera, the work soon became too heavy for this, and he was obliged to restrict himself to the treatment of applications, or of cases he might hear of; and if either of the other medical gentlemen attempted any house-to-house visitation, he soon from similar causes gave it up. So that in fact there had not been in Carnarvon such house-to-house visitation as is required by Sect. IV. of the Order.

Mr. David Thomas, the relieving officer, had instructions to visit every cholera-house, to disinfect the privy, to sprinkle disinfectants about the rooms, and to leave disinfectants (carbolic acid and chloride of lime), in the supply of which there was no stint, with the inhabitants. He had, besides, to superintend the limewhiting, the burning of bedding, &c., &c. He did all he could, and as much as few men would have accomplished ; but having regard, under the peculiar circumstances of Carnarvon, to the extreme need of systematic and constant disinfection, other and special provision for this purpose had been necessary.

No patients had been taken to the hospital ; but a wing of the workhouse cut off from all communication with the main building, and having a separate entrance, was ready for the reception of patients. Mr. Doyle, the Poor-Law Inspector, who was at Carnarvon, and with whom I had the pleasure of conferring, had sanctioned this appropriation of part of the building. It seemed to me well adapted to its purpose.

Of other measures it is not necessary to speak specifically, for everything seemed to me to have been done as well as it could be done. Medical aid appeared always to have been given with great promptitude, and the energy and labours of Mr. John Thomas, the clerk to the guardians, and the untiring zeal and meritorious exertions of Mr. David Thomas, the relieving officer, were really beyond all praise.

Advice given.

Besides those measures of immediate cleansing which, as already stated, I had to recommend to the Town Council, I made arrangements, before leaving Carnarvon, for division of the town into five defined districts, each under supervision of the already acting medical officer, but with appointment of a medical or other assistant in each district for the sole and express purpose of house-to-house visitation ; for the separate appointment of disinfectors personally to disinfect in each house in which cholera or diarrhœa occurred ; for notices throughout the town warning the inhabitants against drinking any water that had not previously been boiled ; and I strongly advised the early removal of cholera cases to hospital.

A small committee of the Town Council will sit daily with the Committee of the Guardians, so that no time may be lost in taking action on any nuisances reported by the visitors or otherwise.

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On the various Outbreaks of Cholera.

f. In London by Mr. Radcliffe.

f. By Mr. J. Netten Radcliffe on Cholera in London, and especially in the Eastern Districts.

Contents.

I. Preliminary.

§ 1.

Relation of the Outbreak to Cholera on the Continent.

Cholera in Europe, 1865 and 1866.

The recent outbreak of cholera in the metropolis cannot well be considered apart from the wide diffusion of the disease on the continent of Europe during 1865 and 1866. It is inextricably linked, both chronologically and etiologically, with that rapid dissemination of the malady which, in May of the former year, commencing at the most sacred city of Mohammedanism, Mecca, extended to Egypt, and thence, before the close of the summer, to many places on the eastern and southern coasts of Europe, and in the basin of the Mediterranean. During the autumn the epidemic spread largely in the south of France and in Spain, appeared at Altenburg in Saxony (where it was introduced from Odessa)* and extended to several neighbouring towns, broke out with severity in Paris, and infected slightly our own coast at Southampton. From the 24th September to the 4th November 35 individuals succumbed to the disease in the last-named seaport town; and from the 28th September to the 31st October, nine deaths occurred from cholera (an off-shoot of the Southampton outbreak) at Theydon Bois, in Essex, a hamlet lying about 11 miles in a direct line N.N.E. from Bow bridge. As the winter of 1865-66 advanced the epidemic extended to North-western France, chiefly affecting the departments of Finisterre, Morbihan, and Côtes du Nord; and throughout the cold season it manifested more or less activity along the opposite coast of the channel. In the North-east, the department of

* Die indische Cholera in Sachsen, 1865; Dr. Rudolf Günther, p. 9.

the Vosges received the infection. With the increasing spring the disease became more rapidly disseminated. In several localities of Belgium and Holland it early showed itself. As the summer grew and its mid-season approached, the diffusiveness of the epidemic augmented largely. The malady reappeared in several cities and towns of Eastern, Southern, and Western Europe which had suffered from it the previous year; it spread generally throughout the provinces of Belgium and Holland, and extended widely in Prussia, Central Europe, and European Russia.

The epidemic broke out in Rotterdam prior to the 21st April; in the port of Antwerp on the 19th May; in Stettin before the 2nd June; in St. Petersburg on the 26th June, or somewhat earlier; in Memel before the 10th July; and in Dantzig before the 12th of the same month.*

§ 2.

Relation of the Outbreak to Cholera elsewhere in England.

At the outset of the increased diffusiveness of the epidemic in 1866 England came within its range. Before, indeed, any news had reached this country of cholera having appeared in Holland, and before probably the existence of the disease was suspected in that country itself, two events had occurred at sea in ships sailing from an English port of remarkable interest.

On the 28th May, 1866, the screw-steamer "England" sailed from the Mersey having on board 807 passengers, more than half of whom were foreigners, Dutch and German, who, a few days before, had journeyed to Liverpool from Rotterdam by way of Hull. The vessel touched at Queenstown on the evening of the 29th, and there received additional passengers to the number of 393. Five days subsequently cholera appeared among the foreign emigrants, extended rapidly in the steerage, and when on the 30th April,—17 days after the commencement,—the outbreak came to an end, in Halifax harbour, the sick-roll included upwards of 500 cases, the death-roll at least 280.

Six days after the "England" had sailed from the Mersey, a sister ship, the "Virginia," followed from the same harbour. She had then on board 807 passengers, of whom 465 were foreigners who had also travelled to Liverpool from Rotterdam by way of Hull. This ship, as the "England," touched at Queenstown, to complete her complement. On the eighth day after sailing cholera broke out on board, again among the foreign passengers; and in 41 days, on the voyage and at the New York quarantine station, swept off 105 souls.

Cholera in England, 1866.

Before a knowledge of these facts, and of the probable transmission of the infection of cholera across the kingdom, had reached England, an instance of importation of the disease into the West Midland Counties occurred. On the 22nd of April, before which date cholera had shown itself in Rotterdam, a traveller sailed from that port for London. He had dwelt in the former city only since the 11th of the month, having on that day arrived there from Java. He reached the metropolis early on the morning of the 23d, and proceeded at once by railway to Bristol. While in the train he was taken ill, and after 18 hours sickness he died, having manifested all the symptoms of confirmed Asiatic cholera.

On the 2nd May two German emigrants died from cholera in Liverpool; others also succumbed to the disease in the town before embarkation and

* The facts in this and the subsequent section, except where otherwise stated, are taken from official communications to the Privy Council. For the detailed history of the epidemic in 1865, see my report on "The Source and Developement of the present diffusion of Cholera in Europe," *Eighth Report of the Medical Officer of the Privy Council* (1865), pp. 306-391.

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previous to the close of June. All had travelled to Liverpool by way of Rotterdam. During the two months three vessels, carrying Dutch and German emigrants, sailed from the Mersey, each of which suffered from an outbreak of cholera. One, the "Helvetia," put back when the disease appeared, and her passengers underwent a sharp visitation in the Mersey.

From the 13th May to the 26th June five cases of cholera were registered in the borough of Liverpool, apparently "quite unconnected with foreign emigrants."* On the 1st July an undoubted case of epidemic cholera among the ordinary population occurred, the starting point of the subsequent outbreak.

But in the meanwhile the epidemic had appeared elsewhere in the kingdom. Between the 10th and 13th of June it broke out again in Southampton, and from the 12th to the 17th of the same month cases occurred at Northwich, in Cheshire, a small market town, situated about 24 miles in a direct line, S.E. of Liverpool and Birkenhead. On the 23rd June a boy died from cholera in the South Dock, Sunderland, on board a steamer from Stettin. On the 28th and 29th June two fatal cases occurred in Goole harbour on board an English steamer which had arrived the morning of the first-named day from Antwerp. On the 29th also a death from cholera took place on board a barque which had arrived that day from Hamburg in the Tyne, off Shields. A fatal case, moreover, occurred on the 1st July off the east coast at Harwich, in a vessel from Brussels; and another fatal case on the 3rd July, on board a coasting vessel, off the south coast in Torbay.

The commencement of the outbreak in the metropolis has its legitimate place chronologically in the foregoing series of facts. The earliest undoubted cases which initiated the outbreak occurred on the 26th June, and contemporaneously with its early development the epidemic broke out not only in Liverpool (1st July) but also in Llanelly (6th July) a seaport town in South Wales. It appeared, moreover, in South Shields and Newcastle on the 16th July. In the last-named town the mate from an Antwerp steamer died from the epidemic on that day.

The latter facts read with the whole of those which precede them show that the outbreak in the metropolis was one of a succession of phenomena which indicated a wide-spread diffusion of cholera infection in the kingdom during the month of June; also that this diffusion was inseparably connected with a direct dissemination of the infection from the continent.

§ 3.

Transmission of the Epidemic to the Metropolis.

Although the foregoing broad conclusion flows naturally from the facts, it is remarkable to observe the scarcity of instances of transmission of cholera to the metropolis.

Cholera in the Metropolis, 1865.

On the 22nd October 1865 the widow of a courier died of Asiatic cholera in Frith Street, Soho. The attack had been preceded by five days diarrhœa, "partly in Paris and partly in London,"† cholera prevailing actively in the former city at the time.

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* See the Report of Dr. Trench, Medical Officer of Health for the Borough, on the health of Liverpool during the March and June quarters of 1866. Dr. Trench gives detailed accounts of the outbreaks in emigrant ships leaving the port of Liverpool. See also respecting the outbreak in the ship "England," Deputy Inspector-General Barrow's narrative published in the sixth volume of the Army "Statistical, Medical and Sanitary Reports," p. 363.

† Weekly Return of Births and Deaths in London, October 28th 1865.

On the 23rd of April 1866, as already related, a mariner from Rotterdam passed through London on his way to Bristol. Soon after leaving the metropolis he was seized with cholera. He had resided in Rotterdam eight days, and the epidemic had appeared in that city before he left it.

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The first case is the only instance made known of fatal cholera occurring in London, prior to the development of the epidemic, in which the disease may be assumed to have been contracted in an infected district on the continent; but contemporaneously with the commencement of the outbreak in the metropolis two cases of importation of the disease occurred.

Imported cases, 1866.

On the 11th July, a German woman died in the London Hospital from cholera. She was the servant of a Dutch cattle dealer, and had come over from Holland on the 6th of the month. Her illness commenced during the passage.*

On the 6th July 1866, a mate in the merchant service died of "Asiatic cholera" at 23, Keeton's Road, Bermondsey. He had arrived in the Thames, with a cargo of fruit from Rotterdam, on the 7th of the month.†

The first death from cholera occurring in the river took place on board a barge off St. George's stairs, Deptford, on the 17th July. The first case of death from cholera on board the "Dreadnought" hospital ship, occurred on the 18th July.‡

The freedom of the metropolis and the port of London from imported cases of cholera prior to July 1866, notwithstanding the incessant and rapid intercourse maintained with infected districts of France and Holland, is certainly remarkable; but the facts known represent the greatness of our ignorance rather than the accuracy of our knowledge. The vastness of the metropolitan population, and the magnitude of the daily changes taking place among it, foil all attempts to trace out the first beginnings of an epidemic of which a barely troublesome diarrhœa is frequently the earliest, as it is unquestionably the most dangerous, because most insidious agent.

I am unable, after diligent and protracted search, to bring forward any facts which would establish the direct dependence, by transmission, of the recent outbreak upon the outbreaks previously occurring in Western Europe; and I am equally unable, after an investigation not less carefully carried out, to show a disconnexion between the former and the latter. I relate the facts and restrict myself to them.

§ 4.

Prevalence of Diarrhœa prior to the Outbreak.

Diarrhœa preceding the outbreak of cholera.

The extent to which diarrhœa prevailed in the metropolis immediately, and for some little time, prior to the outbreak of cholera is a subject of great interest in reference to the etiology of the epidemic. Diarrhœa is fatal to a greater or less extent in every season, and in every week of the year, among the metropolitan population. From the fifth week of 1866 (ending February 4th), to the 23rd week (ending June 10th), with two exceptions, namely, the weeks ending the 18th March and 8th April, the mortality from diarrhœa was in excess of the average of the corresponding weeks of the previous 10 years. During the two weeks ending June 17th and 24th the mortality from diarrhœa fell below the average. In the week ending July 1st the mortality from the disease again exceeded the average; and in subsequent weeks the number of deaths became still more largely in excess contemporaneously with the development of epidemic cholera.

* The Medical Times and Gazette, July 14th 1866, p. 37.
† Registrar-General's Weekly Return, Jan. 21st.
‡ Ibid. p. 242.

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But although the mortality from diarrhœa in the week ending the 1st July, and for many weeks afterwards, exceeded the average, during the first four weeks of this period of excess, the mortality fell considerably below that arising from the same disease, with a higher range of temperature, in the corresponding weeks of the preceding year, 1865. (*See Appendix, Table I.*)

DEATHS FROM DIARRHŒA.

Week ending.	1865.	1866.	Average of corresponding weeks, 10 years.	Mean temperature.	
				1865.	1866.
July 1 June 30	184	67	58·7	59·5	66·3
July 8 „ 7	301	102	95·1	66·1	56·3
„ 15 „ 14	267	150	119·0	61·4	68·2
„ 22 „ 21	280	221	164·1	63·6	62·2

It is also noteworthy, that in the last week of June and first week of July the divergence of the mortality from the average in excess was but slightly greater than that which occurred in the 12th week of the year (ending 24th March), and the 13th (ending 31st March); whilst it was below the divergence occurring in the seventh week of the year (ending 17th February), and the ninth (ending 3rd March). In the weeks ending July 14th and July 21st, the mortality from diarrhœa had become markedly in excess, although less so than in the corresponding weeks of the previous year.

These facts will help in determining when the diarrhœa, peculiar to the outbreak of cholera, and forming part of it, began to override the diarrhœa peculiar to the season of the year. The question is one of considerable difficulty, but one a solution of which is much to be desired.

Great development of diarrhœa since 1832.

Since the first great outbreak of epidemic cholera in this country in 1832–33 an enormous development of diarrhœa has taken place in the metropolis, as in the rest of the country generally. (*See Diagram I. and Table II.*)

In 1838 the deaths from diarrhœa registered in London numbered 393; in 1865 they numbered 3,557. Taking periods of five years, from 1841 to 1865 inclusive, in the first five 3,549 deaths from diarrhœa were registered; in the second 11,388; in the third 12,041; in the fourth 12,207; and in the fifth 13,226. Or, to compare the periods more accurately and with reference to a steadily increasing population, the average annual mortality during the first five years among every 100,000 souls was 34; in the second 101; in the third 106; in the fourth 91; and in the fifth 91.

The second and the third periods of five years include the cholera epidemics of 1848-49 and 1853-54, and the excessive mortality from diarrhœa during the inception and progress of the latter is shown by the exceptional average death rate; but during the two succeeding periods of five years (1856-60 and 1861-65), notwithstanding the freedom of the kingdom from epidemic cholera, the excessive mortality from diarrhœa persisted almost at the rate of the cholera periods, and at well nigh three times the rate of the first five years of the series (1841-45).

The remarkable and persisting growth of diarrhœa here indicated is commonly held to have some intimate etiological relationship with the intrusion (or, as the opinion may be, springing up) of cholera in an epidemic form within our coasts.

The first great augmentation of the mortality from the disease occurred

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in the two years preceding the cholera epidemic of 1848-49, and the augmentation reached its greatest pitch during the epidemic.

The second great augmentation took place in the two years immediately preceding the cholera epidemic of 1853-54, two or three years intervening between the second and third epidemics, and reached its maximum also during the epidemic.

The greatest augmentation of the 28 years took place in 1865, the year preceding the recent outbreak; but the maximum was reached in the same year, and not in the subsequent epidemic year, as in the previous outbreaks.

Each epidemic of cholera since 1838 has been preceded by an excessive development of diarrhœa, but every excessive development of diarrhœa has not been accompanied by epidemic cholera. Thus in 1857, 1859, and 1861 the mortality from diarrhœa was unusually great. In the first-named year the deaths from the disease largely exceeded those from the same cause which preceded the epidemic of 1848-49. In 1859 the mortality from diarrhœa surpassed that which occurred during the second and principal year of the epidemic of 1853-54; and in 1861 the deaths from the same cause were in excess of those of the first year of that epidemic.

Relation of sporadic to epidemic diarrhœa.

The absence of constant concurrence between years of excessive prevalence of diarrhœa and years of epidemic cholera is not the only point of deviation between the phenomena. When they occur together the large amount of diarrhœa accompanying and developed during the progress of the epidemic does not merge insensibly into, or seem to arise directly and by steadily increasing elevation out of, as a further exaggeration, the diarrhœa immediately preceding it. It appears, indeed, to be a superadded phenomenon following a special law of increase and decline.

During the recent epidemic, in the second and third weeks of June, the mortality from diarrhœa fell much below the average, and it was not until the second week of July (the third week of the outbreak) that an increase of the mortality above the average exceeded the rate of variation in excess which had already occurred in an earlier period of the year.

Deaths from Diarrhœa.

June.	1865.	1866.	Average of corresponding Weeks, 10 years.
1st week	44	22	18·9
2nd „	93	20	29·1
3rd „	187	43	48·8
4th „	184	67	58·7

Little prevalence of diarrhœa immediately preceding outbreak of cholera.

The little prevalence of diarrhœa in the metropolis, indicated by the mortuary returns during the two weeks immediately preceding the earliest cases of the epidemic, is confirmed by an examination of the state of diarrhœa among the sick poor, during the months of May, June, and July, in the districts which suffered most from the outbreak. In Stepney during the two weeks referred to only seven cases of diarrhœa were attended among the sick poor; in three districts of Bethnal Green there were no cases; in Mile End Old Town there were 14 cases; in Whitechapel (where diarrhœa appeared to be more prevalent than elsewhere in the Eastern districts during the second quarter of 1866)* 50 cases; and in St. George's-in-the-East 10 cases (*See Appendix, Table III.*). In Poplar also (including the sub-districts of Bromley and Bow, in which the epidemic

* The number of cases of diarrhœa entered in the books of the medical officers of the Union during the quarter ending the 30th June 1865 was 251; during the corresponding quarter of 1866, 215.

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first became peculiary active,) the number of cases of diarrhœa was singularly few ; but a difficulty was experienced in separating the actual numbers from the returns week by week, and I am compelled to restrict myself to the general statement.

A like conclusion for the period under consideration is more certainly derived from the returns of mortality. In the Bethnal Green district, out of a population of 105,101, there were in the second and third weeks of June 1866 but three deaths from diarrhœa as compared with nine in the corresponding weeks of the previous year. In Whitechapel, among a population of 78,970, there were in the same period of 1866 two deaths as compared with nine in 1865. In St. George's-in-the-East, in a population of 48,891, (and here only the order was reversed,) the deaths numbered five in 1866, three in 1865 ; but in the fourth week of June, while nine were registered in 1865 none were registered in 1866. In Stepney, with a population of 56,572, there was one death in the two weeks of 1866, five in the corresponding period of 1865. In Mile End Old Town, population 73,064, the deaths were equal in the two years, but in the fourth week of the month two deaths were registered in 1866, eight in 1865. In Poplar, the population being 79,196, no deaths took place in 1866, but six were registered in 1865. Taking the entire mortality from diarrhœa in the foregoing districts during the second and third weeks of June, in 1866 it amounted to 14, in 1865 to 37. (*See Appendix, Table IV.*)

The remarkable subsidence of diarrhœa immediately prior to the development of epidemic cholera in 1866, here shown, was not an exceptional occurrence. A like phenomenon preceded the epidemics of 1848–49 and 1853–54. Dating the actual commencement of the former epidemic from the 40th week of 1848, in the four preceding weeks, the 36th, 37th, 38th, and 39th, the mortality from diarrhœa fell markedly, and in the three latter weeks, indeed, largely below the average. Dating also the active commencement of the latter epidemic from the week in which the deaths from cholera passed above the average, the 37th, the mortality keeping persistently and conspicuously above the average to the close of the year, in the 31st, 32nd, and 34th weeks of that year the mortality from diarrhœa fell largely below the average of preceding years. A similar subsidence below the average did not occur, it is interesting to remark, in the corresponding weeks of 1854, or anterior to the recrudescence of the epidemic that year. Subsequently to the outbreak of the epidemic in 1853, diarrhœa kept steadily above the average of the preceding three years until the re-commencement of the activity of cholera in 1854. The mortality fell to a lower point during the period from the 26th to the 27th week inclusive, but always kept above the average. In the last week of the period the epidemic again became active, and subsequently the mortality from diarrhœa rose and sunk, with its development and declension. (*See Appendix, Table V.*)

DEATHS FROM DIARRHŒA.

Week of Year.	1848.	Average of corresponding Weeks, 5 years.
33rd	81	66
34th	63	66
35th	79	66
36th	61	66
37th	42	66
38th	46	66
39th	44	66
40th	47	21

Week of Year.	1853.	1854.	Average of corresponding Weeks, 3 years, 1850–52.
30th	81	84	70·1
31st	110	142	134·2
32nd	139	195	167·0
33rd	126	192	165·1
34th	137	214	156·1
35th	152	243	139·0
36th	131	276	124·0

From the foregoing data the conclusion appears to me to flow decisively that the excessive diarrhœa accompanying the recent epidemic, as the two previous epidemics, sprang up contemporaneously with the first cases of cholera; and that, as a further consequence, it is to be considered as a phenomenon apart from the extraordinary development of diarrhœa which has occurred within the last quarter of a century.

A glance at the accompanying diagram (*Diagram II.*) will at once show that the curve of diarrhœa from beginning to end of an epidemic follows closely the curve of cholera, a fact confirmatory of the conclusions that the two phenomena are interdependent, and that neither the one nor the other has any necessary connexion with the diarrhœa prevailing commonly and at all times in the country.

Epidemic diarrhœa not necessarily connected with sporadic.

This conclusion, if accepted, would remove a principal argument in support of the belief that epidemic cholera and diarrhœa are outgrowths of the enormous development of ordinary diarrhœa of late years. The latter phenomenon is most probably independent of, although associated with, the former. Both have been confounded together in an epidemic period, but not so inextricably as to forbid an attempt at separation.*

§ 5.

Choleraic Diarrhœa preceding the Outbreak.

As early as the week ending the 28th April 1866, two deaths were registered in the metropolis as occurring from choleraic diarrhœa. One of these deaths, that of an infant three months old, took place in the Broadway, Westminster; the other, that of a child six years old, happened in Hoxton Old Town.

Choleraic diarrhœa 1865, and preceding outbreak in 1866.

It is not easy to assign a determinate value to the term "choleraic diarrhœa." As a cause of death it has for some time appeared annually in the weekly returns for the metropolis. In 1865, deaths from this cause were not referred to by the Registrar-General until the week ending the 22nd July; but in May of that year, a case had been admitted into Guy's Hospital, under the care of Dr. Wilks, which was described as one of "Asiatic cholera." The reporter of the case remarked, that in using this term he simply implied that "it was such a case as would have been so called during the prevailing epidemic of that disease." He adds, "Dr.

* The following information respecting the date when epidemic diarrhœa appeared in several districts of the metropolis in 1866, and for which I am indebted to the courtesy of the Medical Officers of Health, furnishes instructive data confirmatory of the conclusion arrived at in this section. Epidemic diarrhœa appeared in the City of London during the third week of July (first death from cholera 12th July); Wandsworth, last week of July (two deaths from cholera 23rd July); Clapham and Fulham, the first week in August (in the latter district deaths from cholera had occurred during the first and second weeks of July); St. Pancras, the third week of July (first death from cholera 23rd July); Putney, beginning of August; St. Giles, the first week of July; Streatham, Tooting, and Balham, the third week in August; St. Olave, Southwark, the second week of July; and Hackney, late in the second, or early in the third week of July.

"Wilks said that every year he saw one or two such cases, but seldom so "early in the year as this."* At the close of June 1865, two cases of this character occurred in the Borough. One, which proved fatal, took place in Willmott's Buildings, Kent Road, near the centre of the Southwark cholera-field of former epidemics: the patient was a waterside labourer. The other was admitted into Guy's Hospital, the patient being a non-resident, but having been seized with indisposition, in the district.

Writing in July 1865, Dr. Greenhow remarks, "In the cases of "diarrhœa which he had lately seen, and especially in those among "children, the purging had for the most part been profuse, watery, and "attended by much prostration. The pallor and anæmia which en-"sued, even after a brief attack, were indeed very remarkable. He had "seen no case as yet this season to which the term malignant or "Asiatic cholera could properly be applied; but in a few instances "there had been vomiting and cramps, and the cases resembled what "was called by Sydenham cholera morbus, and has since been termed "summer cholera."†

Fatal cases of "choleraic diarrhœa" and of simple cholera were, in 1866, recorded every week from the 28th of April to the 9th June; and on the 28th May a death from "Asiatic cholera," that of a child 10 months old, was registered at Walworth. I append the dates when the cases of choleraic diarrhœa occurred, and the names of the localities in which they happened.‡ On any view of the probable relations of these cases to the subsequent epidemic it is requisite that they should be noted. If it is found impossible to disentangle at the beginning of the outbreak, cases of a quasi-epidemic character from those of a true epidemic character, and to shut out absolutely a theory of the development of the latter by gradation out of the former, it is equally impossible to set aside the fact of exposure of the metropolis to continuous transmission of the epidemic malady from the early autumn of 1865 to the early summer of 1866. The history of the outbreak, where defective, as here, must be completed by deductions drawn from the history of the general epidemic, of which it forms but a part.

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* The Medical Times and Gazette, June 3rd 1865.
† The Medical Times and Gazette, July 22nd 1865.

‡

	Choleraic Diarrhœa.	"Cholera." "English Cholera."
21st April, æt. 6 yrs., 25, Lucan Place, Hoxton Old Town -	1	
22nd ,, æt. 3 ms., 6, Broadway, St. Margaret, Westminster	1	
28th ,, æt. 5 yrs., 1, Gloucester Court, Mile End Old Town - -		1 (suddenly)
6th May, æt. 5 yrs., 5, Gibraltar Walk, Hackney Road - - -		1
11th ,, æt. 4 yrs., 4, Victory Place, Bermondsey - -	1 (6 hrs)	
12th ,, æt. 23 yrs., 13, Albert Square, Shadwell - - - -		1 (3 days)
21st ,, æt. 4 yrs., 4, Duke Street, Chelsea - - - - -		1 (10 days)
20th ,, æt. 56 yrs., St. Luke's Workhouse - - -	1 (14 days)	
[28th ,, æt. 10 ms., 58, North Street, Walworth -	Asiatic cholera	1 (1 day)]
31st ,, æt. 5 yrs., 3, Charles Street, Bethnal Green -	1 (24 hrs., convulsions 6 hrs.)	
1st June, æt. 49 yrs., 18, North Street, Marylebone - -	1 (48 hrs.)	
2nd ,, æt. 33 yrs., 1, Duke's Lane, Kensington - - - -		1
6th ,, æt. 6 ms., 47, South Street, Mayfair - - -	1 (4 days)	
12th ,, æt. 8 ms., 3, Archibald Street, Bromley - -	1	
,, ,, æt. 11 ms., 16, Dowson's Place, Mile End New Town	1 (7 days)	
13th ,, æt. 55 yrs., 6, Swan Court, Newington - - - -		1 (3 days)
21st ,, æt. 7 wks., 4, Nursery Place, Walworth - - - -		1 (4 days)
,, ,, æt. 11 ms., 21, Old Bethnal Green Road - -	1 (exhaustion.)	
22nd ,, æt. 14 yrs., 51, Wellington Place, Holloway - - -		1 (38 hours, syncope)

II. The Outbreak.

§ 1.

The Earliest Cases.

Earliest cases of the outbreak.

The earliest unquestionable cases of the outbreak took place on the 26th of June 1866. On that day a labourer engaged in a brush manufactory and his wife, each aged 46 years, were seized with undoubted epidemic cholera, and both died the day following, the former after fifteen the latter after twelve hours' "illness," at No. 12 Priory Street, Bromley, a street on the extreme verge of the eastern limits of the metropolis, and situated on the banks of the river Lea.

The same week, on the 25th June, two girls, aged respectively two years and six years, were carried off, after eighteen hours' illness, by "English cholera," at 20 New Street, Berwick Street, a locality 5½ miles distant, in a direct line W.S.W., from Priory Street.

On the 29th June, a labourer, aged 50 years, died of cholera, at 3, George Street, Hammersmith, on the western verge of the metropolis, and about 12 miles away, in a direct line from Priory Street.

On the following day a boy aged seven years died of "English cholera," after 24 hours' illness, at 58 Myddleton Square, Clerkenwell, about 4 miles west of Bromley.

Early cases of cholera and choleraic diarrhœa.

During the following week one fatal case of "cholera" was registered, that of a boy, aged six weeks, who died after 38 hours' illness, at 96, Borough Road, on the south side of the Thames. In the same week also eleven deaths of children, chiefly infants, were returned, as caused by "choleraic diarrhœa." These deaths were distributed in the registration districts of Kensington, Chelsea, St. Pancras, Shoreditch (2), Bethnal Green, Mile End Old Town, Poplar, St. George in the East, Newington, and Lambeth.

Hammersmith.

There is not evidence to show that any of the foregoing cases of cholera, excepting the two occurring in Priory Street, Bromley, on the 27th July, should be assigned to the epidemic. It is far from certain whether the cases of choleraic diarrhœa can be thus excluded. The only case of which there is any definite information occurred in Queen Street, Hammersmith, on the 3d July. Mr. Burge, the Medical Officer of Health for the Fulham district, states that there is a strong presumption that drinking impure water was the actual cause of the child's death. "The family," he writes, "had recently taken possession of "their house, which had been unoccupied a month, and the water had "been retained in the cistern unchanged through defective apparatus; and "of this the family partook, all being more or less affected by bowel "disorders." Two deaths from cholera of a more decidedly epidemic character took place in another house in the same street, on the 9th July, followed by a third case on the 15th. The last-mentioned Mr. Burge attributes to "the result of choleraic infection from exposure to infected bedding."*

Bermondsey.

The third undoubted case of the epidemic took place on the 8th July, at 23, Keeton's Road, Bermondsey. The patient (whose case has been referred to in a previous section) was a mate in the Merchant Service, and had arrived the day previously from Rotterdam, where cholera prevailed.

City Road.

On the 9th, the two cases of cholera which have already been alluded to, occurred at 110, Queen Street, Hammersmith. There would appear to be little doubt from the history of the third case happening in the same house, as stated by Mr. Burge, that these cases form a part of the outbreak. On the same day, also, a fatal case of cholera, of two days' duration, occurred in St. Luke's workhouse, City Road (Hoxton New Town), the patent being 62 years of age.

From this date the nature of the prevailing cases admit of little doubt.

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* The *Lancet*, Dec. 29, 1866, p. 734.

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On the 11th July, a female whose case has been referred to on a previous page, and who had recently arrived in the metroplis, from Holland, died of epidemic cholera in the London Hospital. Two other deaths from the same cause were reported in the course of this day, one an adult, at 1, Crown Terrace (not far distant from Priory Street), Bromley, the other a child, at 72, North Street, Limehouse. A woman also died from cholera, after 12 hours illness, at 21 Devonshire Place, Chiswick, beyond the extreme western limit of the metropolitan area.

Imported case, Whitechapel.

Bromley.

Chiswick.

The distribution of the deaths (9) the subsequent day, the 12th, the first day of marked activity of the epidemic, is of great interest. One took place at Chiswick from choleraic diarrhœa after a day's illness, the patient being a boy two years old; a second, that of a youth, occurred south of the Thames, in the London Road, St. George's, Southwark, after 14 hours' illness; a third, that of an adult, happened after 24 hours' illness, in London Wall, the City. Then, proceeding from west to east, one was recorded in Bethnal Green, another in Limehouse; two occurred in Bromley, and the disease appearing eastwards of the river Lea, a fatal case occurred in Canning Town, and another fatal case at Plaistow. In both the latter instances the patients were adults.

The City.

Canning Town and Plaistow.

Stratford.

The next day, the 13th, Stratford came within the area of the epidemic. A rapidly fatal case of choleraic diarrhœa was reported at the opposite extremity of London, in Hammersmith, together with a case of "English cholera." South of the Thames two adults died of cholera, in Camberwell, one after 12 hours, and the other after 18 hours' illness. A quickly fatal case of cholera also occurred in Keeton's Road, Bermondsey, in the house adjoining that in which the sailor from Rotterdam had died four days before.* Altogether 16 deaths from the epidemic, including two from choleraic diarrhœa, but excluding the case of English cholera, occurred this day, and of the number 11 took place in the East Districts: three in Limehouse, one being the mother of the child who had died in Lower North Street on the 11th; 1 in Ratcliff; 1 in St. George's in the East; 1 in Bethnal Green; 4 in Bow; and 1 in Hoxton New Town (Shoreditch).

Camberwell.

East Districts.

Of 14 deaths occurring on the 14th, including one of choleraic diarrhœa, it is sufficient to say that 3 happened south of the Thames (1, a case of choleraic diarrhœa, the patient being 58 years of age, in Newington, and 2, both in one family, the illness in one case lasting only 10 hours, in Camberwell); 1 in Stratford; 3 in Poplar (one described as "English cholera"); 1 in Ratcliff; 2 in Mile End Old Town;† 3 in Bow; and 1 in Bethnal Green. Eleven of the 14 cases, it is thus seen, occurred in the East Districts.

This diary of the initiatory period of the epidemic shows (1), that at the outset cholera appeared in more than one district of London and its environs well-nigh contemporaneously and (2), that from the commencement of the active increase of the disease, this activity was localized chiefly in the East Districts of the metropolis and adjoining suburbs.

§ 2.

The Progress of the Outbreak.‡

During the week ending the 14th July, the week when cholera began

* Dr. Wm. Parker, the Medical Officer of Health for Bermondsey, states that this patient, the widow of a caulker, had not had any communication with the sailor who had died at No. 23, Keeton's Road, on the 8th July, but that she had been much alarmed by his death.

† I exclude from consideration a case returned from Bethnal Green, as cholera of one week's duration, in a child eight days old.

‡ For the purpose of accurate comparison, the deaths from cholera which occurred in the Registration District of the Metropolis are alone referred to in this section and the two subsequent sections except when otherwise stated.

rapidly to augment, the number of deaths registered from the disease was 32. In the third week following, and fifth from the time of the earliest cases, so rapidly was the epidemic developed, the acmé of the outbreak occurred. The mortality of the seven days, ending August 4th, was 1,053, the highest weekly total during the prevalence of the epidemic; and on the Wednesday of the week, the 1st August, the greatest number of deaths in any one day, 204, took place.

In the week preceding that of maximum mortality the deaths from cholera were 905; in the week immediately following they were 781.

Comparative progress of outbreaks of 1849 and 1854, and 1866.

The rise of the mortality to a maximum has not been paralleled for rapidity in previous epidemics; the subsidence below the maximum was unusually abrupt in its quickness during the first week of fall, but it lagged afterwards as compared with previous outbreaks.

In the outbreak of 1849, assuming that the disease began to spread actively in the 23rd week of the year, the maximum of mortality did not occur until the 14th week of prevalence. But the declension below the maximum, except in the week immediately following, took place more rapidly than in 1866, the number of deaths falling from their highest elevation, 2,026, in the 36th week of the year, to 1,682, 839, and 434 in the three following weeks.

In 1854, the maximum of deaths took place during the 9th week of the outbreak, the active prevalence of cholera being dated from the 29th week of the year; and the rate at which the mortality fell below the maximum was in the 1st and 3rd weeks next succeeding almost equal to, in the 2nd it was less by one-half, but subsequently it was much greater than in 1866. (*See Appendix, Table* VI.)

1866.
Deaths from Cholera in the Registration Districts of the Metropolis from the 26th to the 52nd week inclusive.

Week.	
26th	6
27th	14
28th	32
29th	346
30th	904
31st	1,053
32nd	781
33rd	455
34th	265
35th	198
36th	157
37th	182
38th	150
39th	177
40th	182
41st	207
42nd	144
43rd	112
44th	70
45th	67
46th	32
47th	8
48th	3
49th	1
50th	2
51st	2
52nd	1
	5,548

The decline of the recent epidemic was marked by certain fluctuations of the mortality. The deaths after having fallen to 157 in the 11th week of the outbreak (ending September 8), in the subsequent week rose to 182. During the 13th week (ending September 22) the mortality fell as low as 150; but in the three following weeks it rose respectively to 177, 182, and 207.

From this period (the week ending the 13th October) the mortality steadily declined, and in the last week of September three deaths only from cholera were recorded, the outbreak virtually ceasing after having prevailed since the earliest cases, 23 weeks. (*See Appendix, Tables* VI. *and* VII.)*

* From the 11th to the 25th July inclusive, 7 deaths from cholera and 1 from choleraic diarrhœa took place at Chiswick. This village is situated on the Thames, immediately west of Hammersmith, and just beyond the western limit of the Kensington registration district of the metropolitan area. It constitutes, with its dependencies, a subdivision of the Brentford registration district, and has (according to the census of 1861) a population of 6,505 and an area of 1,311 statute acres. There were 33 deaths from cholera and 2 from diarrhœa in Chiswick during the epidemic of 1848–49; 23 deaths from cholera and 10 from diarrhœa during the epidemic of 1853–54.

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DEATHS from CHOLERA in each Week, and Decrease per cent.

1849.			1854.			1866.		
Week of Year.	Deaths.	Decrease per cent.	Week of Year.	Deaths.	Decrease per cent.	Week of Year.	Deaths.	Decrease per cent.
36th	2,026	–	36th	2,050	–	31st	1,053	–
37th	1,682	–17	37th	1,549	–24	32nd	781	–26
38th	839	–50	38th	1,284	–17	33rd	455	–42
39th	434	–48	39th	754	–41	34th	265	–42
40th	288	–34	40th	411	–45	35th	198	–25
41st	110	–62	41st	249	–39	36th	157	–21
42nd	41	–63	42nd	163	–35	37th	182	–
43rd	25	–39	43rd	66	–59	38th	150	–18
44th	11	–56	44th	31	–53	39th	177	–
45th	6	–45	45th	23	–26	40th	182	–
			46th	12	–48	41st	207	–
			47th	8	–33	42nd	144	–30
			48th	7	–12	43rd	112	–22
						44th	73	–35
						45th	67	–8
						46th	32	–52
						47th	8	–75
						48th	3	–62

§ 3.

The Mortality of the Outbreak.

Mortality of Outbreak.

During the 23 weeks of the outbreak, the deaths from cholera (exclusive of those which occurred in suburban districts) amounted to 5·548, from diarrhœa to 2·692.

On comparing this mortality with that which occurred during the outbreaks of 1849 and 1854, the following results are obtained. In each instance, the duration of the outbreak (setting aside the initiatory irruptions of the autumn of 1848, and subsequent winter, and of the summer and autumn of 1853), was about 23 weeks, and extended over the same

The deaths from cholera in 1866 took place at the following dates :—11th July (a woman, aged 52 years, 21 Devonshire Place); 12th July (a boy, aged 2 years, 17 Devonshire Street, choleraic diarrhœa) ; 16th July (a man, aged 37, 9 Wood Street ; also the wife of foregoing, aged 40 years); 18th July (a girl, aged 19 years, 1 Manor Terrace); 20th July (a woman, aged 30 years, 1 Manor Terrace) ; 25th July (a child, aged 3 years, 14 Devonshire Street ; also a woman aged 37 years, 11 Wood Street). The streets in which the deaths occurred lie close together, the houses forming part of a block of buildings, the sanitary surroundings and, as a rule, condition of which, are infamous. The population of the block consists chiefly of labourers and costermongers, the latter for the most part driven out of London by the destruction of cottage property which has of late occurred in the metropolis, and having found it impossible to obtain shelter within their means nearer to their chief field of occupation. These men work with their barrows backwards and forwards to London, dealing even in fish bought in Billingsgate, and extending their rounds to the East Districts of the metropolis. The history of the first case of cholera was not fully elicited ; but the patient was the wife of a labouring man having, so far as is known, little communication with London. At the commencement of the outbreak, the surface wells from which the neighbourhood was almost altogether supplied with water, and which are largely exposed to pollution, were suspected of being concerned in propagating the disease. They were at once most wisely closed, and water obtained from the mains of the West Middlesex Water Company, which draws its supply from the Thames at Hampton. This measure is believed to have limited the outbreak. The Vicar of Chiswick, the Rev. L. W. T. Dale, thought that the well water used by the cases first seized might have been accidentally polluted by some undetected case of diarrhœa, the disease having been contracted in London. The question unfortunately was not made the subject of a careful investigation.

seasons of the year. A comparison, therefore, of the deaths recorded in the different epidemic periods will furnish a tolerably accurate conception of the relative mortality from cholera, and the concomitant diarrhœa in the three last visitations of these diseases to which London has been subjected :—*

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Years.	Duration.	Deaths from Cholera.	Ratio to 10,000 inhabitants.	Deaths from Diarrhœa.	Ratio to 10,000 inhabitants.
1849 - -	23 weeks	13·565	51	2·926	13·0
1854 - -	23 „	10·684	43	2·551	10·1
1866 - -	23 „	5·548	18	2·692	8·8

Cholera having been no less fatal in proportion to the number of persons attacked by the disease during the recent invasion than in previous outbreaks,† the foregoing results would indicate increased, and perhaps increasing, safeguards in the metropolis against the diffusion of the epidemic.

§ 4.

The Distribution of the Mortality.

It has been shown in the diary of the earliest cases that at the commencement of the outbreak the activity of the epidemic was confined chiefly to the East Districts‡ of the metropolis. The localization of the epidemic in these districts, together with its rapid culmination, constitute two of the principal characteristics of the outbreak.

Distribution of mortality.

Of the total mortality from cholera of 5·548 souls, no less than 3,909, more than double the amount distributed over the rest of the metropolis, occurred in the East Districts alone. In the districts south of the Thames the deaths numbered 702; in the Central Districts, 329; in the North Districts, 409; in the West Districts, 160. The deaths in the East Districts were, indeed, five times more numerous than in the South Districts; 11 times more numerous than in the Central;

There was a curious recrudescence of the epidemic in the marsh district to the west of Woolwich dockyard, and included partly in Woolwich and partly in Charlton during the weeks ending the 27th October and 3rd November. Within the 14 days no less than 58 deaths from cholera took place in this locality. The disease first appeared at Woolwich in the course of the week ending the 4th August, in Charlton during the week ending the 25th August. In the former place deaths from cholera were recorded every week of September and the two first weeks of October; in the latter place several deaths from the disease took place during the same period. The cause of the recrudescence was not detected. The attacks chiefly occurred among the population living in ill-constructed and dirty cottages, built on marshy soil below the level of high-water mark and apt to be flooded from foul tidal ditches.

* I have omitted from the comparison the outbreak of 1832, in consequence of the imperfection of the records. In the comparative table (IX.) given in the Appendix, I include the returns of deaths from cholera for 1832, and I may add that, according to the figures, the ratio of deaths in 10,000 population during the 23 weeks of greatest activity of the epidemic in 1832 was 23.

† From July 10th to August 30th, 1866, 509 cases of cholera were admitted into the London Hospital. Of the cases admitted during the first week of the period, 85 per cent. died; of those admitted during the last week, 37 per cent.; and the average mortality of the whole period was 54·9 per cent. In round numbers, the deaths were 281, the recoveries, 228.—*London Hospital Clinical Lectures and Reports*, Vol. III., p. 437, 1866.

‡ The East Districts include Shoreditch, Bethnal Green, Whitechapel, St. George-in-the-East, Stepney, Mile End, Old Town, and Poplar, (including Bow and Bromley.

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nine times more numerous than in the North; and 24 times more numerous than in the West.

It was in the East Districts of the metropolis, moreover, that the disease underwent the rapid and unexampled development which gave to the outbreak such formidable proportions in the fifth and sixth weeks of its duration, and forms one of its most remarkable characteristics. It is true that this rapid increase was reflected in the augmentation of the epidemic in this period over the rest of the metropolis, but this augmentation was so trifling as compared with that of the East Districts as to lead to the surmise that it was a contingent rather than an essential feature of the outbreak in the former localities.

Ratio of mortality from week to week.

A calculation of the ratio of mortality in each week to that of the preceding will show more accurately the magnitude of the development which the outbreak underwent in the East Districts, as well as the relative progress of the mortality from it in these districts, and the rest of the metropolis, week by week. The results prove that notwithstanding the great disproportion in the number of deaths from cholera in the East Districts as compared with the rest of the metropolis, that in the fourth week only of the outbreak did the ratio of augmentation largely surpass that undergone in other districts. In the fifth week the ratio of increase was nearly the same all over the metropolis; in the week the next after that the rate of increase in the East Districts fell below that of the rest of the metropolis; and in the three succeeding weeks the comparative decrease was much more rapid.

1866.

Weeks ending	Weekly Deaths.		Ratio per cent. of Increase or Decrease in each Week on the Deaths in preceding Week.	
	In the East Districts.	In the rest of London.	In the East Districts.	In the rest of London.
			Per cent.	Per cent.
July 7	9	5	—	—
„ 14	20	12	—	—
„ 21	308	38	1,440 increase	216 increase
„ 28	818	86	165 „	126 „
Aug. 4	916	138	11 „	60 „
„ 11	673	108	26 decrease	21 decrease
„ 18	369	86	45 „	20 „
„ 25	198	67	46 „	22 „
Sept. 1	122	76	38 „	13 increase
„ 8	74	83	39 „	9 „
„ 15	77	105	4 increase	26 „
„ 22	56	94	27 decrease	10 decrease
„ 29	55	122	1 „	29 increase
Oct. 6	50	132	9 „	8 „
„ 13	65	142	30 increase	7 „
„ 20	34	110	47 decrease	22 decrease
„ 27	26	86	23 „	21 „
Nov. 3	13	60	50 „	30 „
„ 10	16	51	23 increase	15 „
„ 17	14	18	12 decrease	64 „
„ 24	3	5	78 „	72 „

The table only refers to the deaths within the registration division of London, and therefore does not include the deaths in West Ham and Stratford.

From this period the course of the epidemic in the East Districts and the rest of the metropolis differed considerably. In the former localities the decline of the outbreak was interrupted by slight fluctuations during the weeks ending the 15th September, 13th October, and 10th

November. In the rest of the metropolis the disease underwent a considerable increase, and attained a second and higher maximum in the eighteenth week. The first maximum of mortality (138) in London, exclusive of the East Districts, occurred during the week ending the 4th August, the week of greatest mortality in the latter districts; the second maximum of mortality (155) took place 10 weeks afterwards.

Ratio of mortality from week to week in the outbreaks of 1849 and 1854.

The magnitude of the development which the epidemic underwent in the East Districts as compared with the rest of the metropolis during the fourth week of prevalence, and the transitoriness of this development are phenomena altogether peculiar to the recent outbreak. No relative development of like magnitude, suddenness, and shortness of duration has occurred in previous outbreaks of cholera in the metropolis. This is shown by the following tables of the relative progress from week to week of the mortality from the epidemic during its period of increment in the South Districts and rest of London in the outbreaks of 1849 and 1854. The brunt of the malady in those years fell upon the South Districts, and they suffered to a much greater extent from its ravages than the East Districts in the past year.

1849.

Weeks ending	Weekly Deaths.		Ratio per cent. of Increase or Decrease in each week on the Deaths in preceding week.	
	In the South Districts.	In the rest of London.	In the South Districts.	In the rest of London.
June 9 -	6	16	—	—
„ 16 -	24	18	300 increase	12 increase
„ 23 -	16	33	33 decrease	83 „
„ 30 -	45	79	181 increase	139 „
July 7 -	93	59	106 „	25 decrease
„ 14 -	192	147	106 „	149 increase
„ 21 -	443	235	130 „	59 „
„ 28 -	514	269	16 „	14 „
Aug. 4 -	621	305	20 „	13 „
„ 11 -	476	347	23 decrease	13 „
„ 18 -	554	676	16 increase	94 „
„ 25 -	477	795	13 decrease	17 „
Sept. 1 -	730	933	50 increase	16 „
„ 8 -	1,071	955	46 „	2 „
„ 15 -	846	836	21 decrease	12 decrease
„ 22 -	422	417	50 „	50 „

1854.

Weeks ending	Weekly Deaths.		Ratio per cent. of Increase or Decrease in each week on the Deaths in preceding week.	
	In the South Districts.	In the rest of London.	In the South Districts.	In the rest of London.
July 22 -	8	18	—	—
„ 29 -	71	62	787 increase	244 increase
Aug. 5 -	290	399	308 „	543 „
„ 12 -	466	178	60 „	55 decrease
„ 19 -	370	359	20 decrease	101 increase
„ 26 -	460	387	24 increase	7 „
Sept. 2 -	670	617	45 „	59 „
„ 9 -	972	1078	45 „	74 „
„ 16 -	856	693	11 decrease	35 decrease

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Ratio of mortality in different districts.

A more accurate knowledge of the distribution of the epidemic over the metropolis is obtained from its comparative mortality in the different registration districts.*

The rate of mortality from cholera, per 10,000 population, throughout the whole of the metropolis, was 18·4. Out of the 36 registration districts into which London is divided, in seven only did the mortality surpass the average, namely, in six of the East Districts—Bethnal Green, Whitechapel, Saint George in the East, Stepney (Limehouse), Mile End Old Town, and Poplar—and in the Greenwich district. In the latter district the mortality was 19·5; in the former districts the minimum mortality was 60·4 (Bethnal Green), the maximum 107·6 (Stepney, Limehouse). Between the rate of mortality in Greenwich district and that of Bethnal Green there was no intermediate rate, in the metropolis, except in the subdistrict of Greenwich town, where the deaths ranged 1·2 above the average. The Greenwich town rate of mortality (20·7) was the highest in the metropolitan districts outside the East Districts. From 20·7 to 60·4 is a complete break, and its magnitude strikingly shows the enormous preponderance of the epidemic in the last-named localities. (*See Table* IX.)

But the suburban districts lying adjacent to the East Districts of London, separated from them by the river Lea†, but in reality conterminous with them, furnish an intermediate rate of mortality—a rate, however, little less remarkable in its amount as compared with the maximum of the metropolitan districts exclusive of the East. In West Ham the average mortality from the epidemic was 49·3, while in the adjoining district of Stratford the death rate (77·6) well-nigh rivalled that of Whitechapel. That is to say, two country districts situated partly on the alluvial flats of the rivers Lea and Thames, partly on the slopes of the Essex hills, almost equalled in mortality the most severely visited localities of the metropolis, localities in which the populations, perhaps, were in no respect so favourably situated as to aëration and packing, although otherwise differing little in sanitary state and condition. In the localities conterminous to the north and west with the East Districts of London, some of which are as unfavourably circumstanced hygienically as the latter, the highest rate of mortality did not exceed 15·7, whereas in the suburban districts directly east of the river Lea the lowest average was upwards of three times greater. This anomaly constitutes another marked and exceptional characteristic of the outbreak. In previous outbreaks the chief force of the epidemic was expended within the metropolitan area; in the recent outbreak it extended to an extra metropolitan district.‡

* I adopt the calculations of the Registrar General in the *Summary of Weekly Returns of Births, Deaths, and Causes of Death in London for* 1866 (pp. xviii–xix.) In these calculations the deaths from cholera in hospitals have been distributed in the various districts from whence the patients were received; or, if this was not practicable, and the patients did not belong to the district in which the hospital was situated, their deaths have been excluded. The Registrar General's calculations extend to the entire returns of "cholera" for the year; but as the number of deaths assigned to this cause which were recorded before and after the epidemic amounted to 27 only, dispersed in various districts, they do not exercise a perceptible influence over the results. Straftord and West Ham are not included in the metropolitan returns.

† The Rivers Pollution Commissioners have spelled the name of this river *Lee* All the standard maps and geographical works of reference spell the name *Lea.* I have adhered to the orthography commonly used.

‡ It must be understood that these remarks refer to the *comparative* prevalence of cholera in the metropolitan and suburban districts. The registration district of West Ham, which includes Stratford, has always suffered severely from the epidemic. In 1849 there were 134 deaths from cholera in this district; in 1849, 124; and in 1867, 367. But in 1849 the mortality was 50 per 10,000 population, as compared with 166 in the districts chiefly affected South of the Thames, and 33 in 1854, as compared

Districts of least and greatest mortality.

The lowest average mortality (taking the whole field of epidemic prevalence) occurred at Hampstead* (0·8); the next lowest in St. George, Hanover Square (1·7) In eight of the remaining districts of slight prevalence, the rate of mortality ranged below 5; in 15 from 5 to 10; in four from 10 to 15; and in two from 15 to 20.

In the districts of greatest prevalence the rate of mortality ranged from 49·3 to 107·6: Stepney (Limehouse) suffering the most, Poplar (90·8) next in grade; and West Ham least. (*See Map* II. *and Table* IX.)

DISTRICTS OF SLIGHT PREVALENCE OF CHOLERA.

Mortality less than 5 *per* 10,000 *population.*

Kensington.
Chelsea.
St. George, Hanover Square.
St. Martin-in-the-Fields.
St. James, Westminster.
Marylebone.
Hampstead.
Islington.
Newington.

Mortality from 5 *to* 10 *per* 10,000 *population.*

Westminster.
St. Pancras.
St. Giles.
Strand.
Holborn.
Clerkenwell.
St. Luke.
London, City.
St. Saviour, Southwark.
St. Olave, Southwark.
Rotherhithe.
Bermondsey.
St. George's, Southwark.
Lambeth.
Wandsworth.
Camberwell.
Lewisham.

Mortality from 10 *to* 15 *per* 10,000 *population.*

Hackney.
East London.
West London.
Shoreditch.
Leyton.

Mortality from 15 *to* 20 *per* 10,000 *population.*

Woolwich.
Greenwich.

DISTRICTS OF GREAT PREVALENCE OF CHOLERA

Mortality per 10,000 *population.*

West Ham - -	49.3
Stratford - - -	77.6
Bethnal Green - -	60.4
Whitechapel - -	84.0
St. George-in-the-East	87.9
Stepney - - -	107.6
Mile End Old Town -	67.7
Poplar - .. -	90.8

Distribution of diarrhœa.

The distribution of the mortality from diarrhœa differed in some particulars from that of the mortality from cholera. The three districts (Stepney (*Limehouse*), Poplar, and St. George-in-the-East,) in which the mortality from cholera was greatest, were also those of the largest mortality from diarrhœa. But the mortality from diarrhœa in Holborn (16·9), with a death-rate of 5·2 from cholera, was but a fraction greater than the rate in Bethnal Geeen (16·4), with a death-rate of 60·4 from cholera. The death-rate from diarrhœa in St. Giles (16·1), in which the mortality from cholera was at the rate of 9·2, almost equalled that of Bethnal Green, and was the same as that of Whitechapel (16·1), the death-rate from cholera in the latter districts being 84·0. The districts of greatest prevalence of diarrhœa next in order, were Clerkenwell (14·5), Fulham (13·4), St. Luke (13·2), Bermondsey (12·8), Kennington (12·4), Mile End Old Town (12·1), St. Martin-in-the-Fields (11·7), Marylebone (11·3), and West London (11·0). The average rate of mortality from diarrhœa for the whole of the metropolis was 10·5.

Distribution of mortality in previous outbreaks.

The slight degree of prevalence of the epidemic in the districts south of the Thames is not less remarkable than the localisation of the chief intensity of the outbreak in the East Districts and the contiguous localities of Essex. In the epidemic of 1832 the brunt of the epidemic fell with tolerable equality upon both the South and the East Districts, and Whitechapel suffered to a greater extent than in the recent outbreak. But in the epidemics of 1849 and 1854 the chief

with 117 in the latter districts. In the past year (1866) the mortality from cholera in the West Ham registration district per 10,000 population was 46; in the conterminous East Districts of the metropolis, 72.

* Mr. C. F. J. Lord, the Medical Officer of Health for Hampstead, has informed me that the whole of the cases (3) occurring in Hampstead were imported.

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intensity of the outbreaks was, with one exception, concentrated in the South Districts. The exception referred to occurred in 1854, when St. James, Westminster, suffered to an almost equal extent with the most severely visited districts south of the Thames. During the recent outbreak the average mortality in the latter districts was 6·2, during the outbreak of 1849 it was 147·2, during that of 1854 114·8. (*See Appendix, Table* IX.)

There was this in common between the localities of greatest prevalence of the epidemic in 1866, 1849, and 1854, namely, the definiteness of the area chiefly affected, notwithstanding the general diffusion of the disease over the whole of the metropolis. There was one principal local condition which had proved mainly efficient in determining the chief localities of epidemic development in the two earlier outbreaks—a condition removed prior to the last—and the lesson was not lost in dealing practically, at the moment, with the recent outbreak.

§ 5.

The Special Phenomena of the Outbreak.

Special phenomena of outbreak.

From the facts set forth in the preceding pages, the peculiar phenomena of the recent outbreak appear to unfold themselves without constraint.

Normal development of epidemic.

1. It is obvious that immediately prior to the explosion of cholera in the East London districts and neighbouring suburbs across the Lea, a few cases of cholera existed far apart in various localities of London. The progress of the outbreak in the districts other than the East London suggests the conclusion that this represents the normal development of the epidemic, the explosion in the East being a superadded phenomenon. The slight increase of the disease in the rest of London, contemporaneously with its remarkable development in the East Districts, does not militate against this conclusion. Two causes were acting at the time to which this increase might have been due, and both probably were efficient (as will subsequently be shown) in bringing it about. The first was the importation of the disease from the districts of explosion; the second the unusually high temperature prevailing at the time. The increase was marked in the South, the West, and the North Districts, but chiefly in the two former.

Explosion of disease in the East Districts.

2. It is further obvious that the unusual development of the epidemic in the East Districts as compared with the rest of London, began in the week ending the 14th July, and it is highly probable that it commenced about the 11th of the month. It is also certain that that rapid increase of the disease, to which the term "explosion" has been aptly applied, took place during the week ending the 21st July. It would appear, moreover, to be almost unquestionable that the determining cause of the explosion did not act manifestly after the close of the week in which the explosion occurred. For this would seem to be the legitimate conclusion to attach to the fact that in the week following the ratio of increase, enormously in excess in the preceding week, had fallen well-nigh to that which then obtained in the rest of the metropolis.* It appears as if some cause temporarily acting had given a vast impulse to the development of the epidemic in a limited locality, and that thenceforwards the progress of the disease was governed by the laws which commonly regulate its rise and fall. It must be observed, however, that the subsidence of the disease in the

* See on this subject the third portion of the Report of the Lancet Sanitary Commission, "On the Epidemic of Cholera in the East End of London." (*Lancet, September* 8, 1866, p. 275.) Dr. Edward Divers carried out the investigation for that journal.

East Districts does not altogether tally with this view, unless on the supposition of a previous exhaustion of the susceptible among the population.

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Assuming, then, that the cause of the explosion began to act during the week ending the 14th July, and that it ceased to act in the subsequent week, it becomes important, as a preliminary step to an attempt to discover the nature of the cause, to ascertain accurately in what localities and over what area in the East Districts the explosion occurred.

Area of Explosion.

The earliest deaths in the week ending July 14th, took place on the 11th of the month. They were three in number. One occurred in Bow, another in Limehouse, and the third (a case imported from Rotterdam) in the London Hospital.

On the 12th there were six deaths distributed in the following districts and sub-districts,—Bethnal Green, Limehouse, Bow, Bromley, Canning Town, and Plaistow.

On the 13th, of 12 deaths, three occurred in Limehouse, four in Bow, one in Ratcliff, one in St. George-in-the-East, one in Bethnal Green, one in Shoreditch, and one in Stratford.

On the 14th, of 11 deaths, three took place in Bow, three in Poplar, one in Ratcliff, two in Mile End Old Town, one in Bethnal Green, and one in Stratford.

Thus it would appear that the 32 deaths from the epidemic occurring during the last four days of this week, were distributed over the whole of the East Districts, excepting Whitechapel; also over a district beyond the River Lea, which is bounded by Stratford on the North, Plaistow on the East, and Canning Town on the South, both the latter places being included in the West Ham registration district.

Twelve deaths occurring on the 15th July were distributed in various proportions over several of the districts already indicated, namely, Limehouse, St. George-in-the-East, Shoreditch, Mile End Old Town, Poplar, Stratford, and West Ham.

The following day, the 16th, Whitechapel was included in the area of explosion, three deaths occurring in this district, all on its western verge, two being in Mansell Street, Goodman's Fields, the third in Raven Row, Spitalfields. Of 30 other deaths which took place during this day, four happened in Limehouse, one in Ratcliff, two in Shadwell, four in Mile End Old Town, four in Poplar, eight in Bethnal Green, two in Bow, four in Stratford, and one in West Ham.

Thus, on the sixth day of commencing activity of the epidemic in the East Districts cholera had appeared in every portion of an area bounded, west of the river Lea, on the north by a line drawn east and west from the south-west corner of Victoria Park; on the west (with the exception of two cases in Shoreditch) by a line running directly north from Little Tower Hill; on the south by the shore-line of the Thames, and on the east by the river Lea. East of the last-named stream the area included Canning Town, Halleville,* Plaistow, West Ham, and Old and New Stratford.

Over the district thus defined there were in six days 77 deaths from cholera, while in the rest of the metropolis and its suburbs there were only 19.

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* Ordinarily the whole of the new suburb which has sprung up on the east bank of Bow Creek is termed Canning Town. In the Registrar-General's Returns, however, this name is restricted to that portion of the suburb which lies to the north of the Barking Road. The portion lying to the south of that road and between it and the Victoria Docks (Halleville) is included by the local registrar in Plaistow.

During the five remaining days of the week, from the 17th to the 21st inclusive, 391 deaths occurred within the district the limits of which have just been described. These deaths were distributed as stated in the margin. In the rest of London and its environs the deaths were 40.

Deaths from Cholera in the East Districts and East Suburbs, 17th to 21st July.

West Ham, (Plaistow, Canning Town, &c.)	22
Stratford	18
Bow, including Bromley	45
Poplar	51
Limehouse	48
Ratcliff	15
Shadwell	10
Mile End Old Town	63
Whitechapel	45
Bethnal Green	44
St. George-in-the-East	30

In the districts conterminous with the area of explosion to the west and north there were but 14 deaths from cholera and choleraic diarrhœa during the fortnight ending the 21st July. Of these deaths three took place in the City, six in Shoreditch, and five in Hackney.

I have marked upon the accompanying map (*See Map* I.*) the localities in which deaths from cholera and choleraic diarrhœa occurred in the metropolis from the 27th June to the 21st July. This map shows more clearly than a verbal description the peculiarity of distribution of the disease sought to be explained in the preceding paragraphs.

III.—Etiology.

In discussing the etiology of the outbreak, I propose, in the first place, to state the result of my inquiries relative to the origin of the two earliest cases; and, in the second place, to examine the extent to which the progress and distribution of the disease were determined by the conditions which have been found more particularly to influence them in former outbreaks. In this category I include the questions of meteorological changes, altitude, nature of soil, density of the population, filth, state of sewerage, locality, and water supply.

§ 1.

Origin of the earliest Cases.

Origin of earliest cases.

The earliest undoubted cases of the outbreak occurred, as already stated, at No. 12, Priory Street, Bromley, on the 26th June 1866. This street is situated on the west side of the river Lea, 242 yards south of Bow Bridge or thereabouts, its eastern extremity being near upon 110 yards from the verge of the river. The street, unpaved, consists chiefly of two-storied cottage-houses, arranged in two continuous rows, one on each side of the roadway. The houses on the southern side (the general direction of the street being from S.W. to N.E.) have each an open space in the rear. In one of these house the deaths occurred. It is a small, wretched, four-roomed dwelling but neither smaller nor worse provided than many scores of houses in the same vicinity; and in respect of the open space behind it, and its aeration, it was infi-

* The whole of the deaths which occurred within the period referred to are not marked in the map. The most elaborate and recent maps of the metropolis do not give all the localities (as for example, many alleys, small yards, and sundry new streets) visited by the cholera; and the residences of persons who had died of the disease were not always stated by the local registrars in sufficient detail to admit of the deaths being approximatively indicated upon the map. It is to be regretted that the registrars do not when they record deaths occurring in back yards and alleys always state the street with which the alley or yard communicates, and in the case of new streets the road adjoining which they are built. It is to be regretted also that in the case of deaths occurring in hospitals greater care is not taken to record upon the certificate of death the street, or yard, or alley, and number of the house, as well as the district, from which the deceased came.

nitely better circumstanced than hundreds of houses of no better class within cannon shot. A small outbuilding projects from the house behind, in the rear of which is a watercloset which requires to be flushed by hand. The drain of this closet passes beneath the house, and opens into a drain which runs along the street. The latter drain communicates with a sewer which empties its contents into the High Street (Bromley) sewer, the last-named sewer delivering them into the river Lea at the south-west corner of Bow Bridge (*See Map* III.). Into the watercloset of No. 12, Priory Street, the discharges of the patients first known to have been attacked with the epidemic, were cast, and they would pass rapidly along the line of sewers mentioned, over a distance of about 300 yards, into the river Lea.

The house has an intermittent water supply from the East London Water Company, the water being stored in an open cask in its rear.

The persons who first succumbed to the epidemic were a man named Hedges, and his wife, both aged 46 years. Both, also, as well as three of their children who lived with them, worked at a cocoa-nut fibre brush manufactory in Marshgate Lane, Stratford, a short distance east of Bow Bridge. The wife was attacked suddenly at home in the course of the 26th June, the husband as suddenly, during the same day, whilst at his work. The former died after 15 hours, the latter after 12 hours illness. They were persons of regular and temperate habits, in excellent repute with their employer, their work-fellows, and their neighbours. I obtained from their oldest son and daughter, both adults, a tolerably close account of their life during the fortnight preceding the fatal illness, but not a fact was elicited which could throw the least light upon the source of the attack. The ordinary routine of their duties had not been interrupted during that period, or for some time previously. Their ordinary domestic habits had scarcely been broken. On the Sunday before the attack accompanied by their daughter and another young female, they had walked through Poplar and the Isle of Dogs to the ferry, crossed over to Greenwich, and strolled for a short time in the park. Returning homewards, the four drank between them at an alehouse near one of the Park gates, a pint of beer, but took no other refreshment. The next day, Monday, the day before they were attacked, the man and his wife, with a friend, spent the evening at a travelling circus in Stratford. Here also no excess was committed, a glass of beer alone being taken by each during the performance. On the Sunday the pair, with their three children and a friend, had dined upon a rabbit-pie with potatoes. The rabbits had been imported from Ostend. A portion of this pie, unconsumed the previous day, served also for the family's dinner on Monday. Neither the children nor the friend suffered any discomfort from this food, neither did the man nor his wife. In other respects the diet of the two days referred to was that ordinarily taken by the family, namely, tea or cocoa, and bread and butter.

So far as the family knew, and that knowledge was such as to justify them speaking with tolerable positiveness, neither the man nor his wife had had any communication, incidental or otherwise, with individuals arriving from infected districts of the continent. Their only acquaintance in the port of London was a bargeman, who occasionally brought his vessel up to Bow Bridge, and when moored there Hedges and his wife would spend some little time on board with him. The barge had been in the Lea about a fortnight before Hedges and his wife were attacked, and as usual they had visited it. Backwards from this point two weeks short of the period over which, according to Griesinger, Wunderlich, and Pettenkofer, the history of early cases, if their origin be doubtful, should

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extend,* the knowledge of the movements of Hedges and his wife becomes obscure. At this period they themselves could alone have furnished a clue to their attack, if indeed such a clue existed.

Their cases were punched, so to speak, as clearly and definedly out of the population immediately surrounding them as a hole is punched out of a tissue. No cases of a doubtful choleraic character could be ascertained to have occurred in any of the adjoining streets shortly before or contemporaneously with the seizure of Hedges and his wife. On this subject it is necessary, however, to speak with extreme caution, from the great difficulty of obtaining information in districts so thickly inhabited, and in which there is a large movement of the population constantly taking place. A little over a quarter of a mile from Priory Street to the south-west in Archibald Street, the death of a child eight months old from "choleraic diarrhœa" was registered on the 12th of June. The father of the child was a mariner, but not engaged in a ship trading to the continent, and I have not any evidence to show that this case belonged to the epidemic.† I sought to ascertain if any communication had taken place between the Hedges family in Priory Street and the mariner's family in Archibald Street, but I failed to discover that any intercourse, accidental or otherwise, had been held, and it seemed highly improbable that such could have happened. But assuming that the case in Archibald Street was a still earlier manifestation of the epidemic than were the cases in Priory Street, the isolation of the latter at the moment in the East Districts of the metropolis was scarcely less remarkable.

The cases themselves were singularly sudden in their invasion, and rapid in their progress to a fatal termination. The daughter's evidence is clear that the commencement of her mother's attack was at once by vomiting and purging together. The statement of a boy, who worked under the father at the brush manufactory, is equally clear that the latter was seized at the outset, whilst at work, with "purging upwards and downwards." Husband and wife were practically attacked contemporaneously; and the seizures were as definite in commencement, and as far separated from the healthy condition of the people about them, as if a poisonous dose of arsenic had been swallowed. Not one of the children was attacked, even with diarrhœa, and not an individual of about 200 persons, men, women, and children, working in the brush manufactory, suffered, so far as I could ascertain, after repeated inquiries, from bowel complaint of any kind, except Hedges and his wife, until a fortnight afterwards, when a brother of the former, living in Stepney, and also working at the manufactory, was seized with cholera, was treated in the London Hospital and recovered. A daughter of this man died of the disease in the London Hospital shortly afterwards. The manufactory is supplied with water by the East London Water Company.

The amount of diarrhœa in Bromley, Bow, Poplar, and the adjacent districts, was exceedingly small in the last week of June and two first weeks of July as compared with the corresponding weeks of 1865, notwithstanding an unusual range of temperature during the first and second of the weeks named. The mean temperature of the week ending the 30th June exceeded the average of the corresponding week during the previous 50 years by 4°·8. The next week the mean fell 5°·1 below the average

* See their instructive pamphlet *Cholera-Regulatif.* A translation of this valuable series of rules for the guidance of sanitary authorities, practitioners, and the public, is published in *The half-yearly Abstract of the Medical Sciences*, vol. xliv., July–Decr. 1866.

† Dr. S. Lawrence Gill, of Campbell Terrace, Bow Road, E., who attended this case, tells me that he had seen other cases in Bow and Bromley of a similar character, but not fatal, during the winter and spring.

named, but in the week following it exceeded the average by as much as 6°·3. I failed to discover any trustworthy traces of epidemic diarrhœa in the district referred to during the period under consideration.

It is thus seen that the two first well-marked cases of epidemic cholera occurred in members of the same family, without premonition, and independently of any augmentation of diarrhœal disease in the immediate locality. Nay more, the evidence is apparently satisfactory that the prevalence of such disease was reduced to a minimum as compared with the corresponding period of the preceding year; and that other members of the infected family, the fellow-workers, or the neighbours, did not suffer from diarrhœal or choleraic disease until a fortnight later. The next deaths, after the deaths of Hedge and his wife, from epidemic cholera in Bromley, occurred on the 11th July, fourteen days from the previous deaths, in Crown Terrace, about 250 yards from Priory Street. The patient was a domestic servant who had recently come from the country. The same day a boy, aged nine years, died from the disease in Lower North Street, Limehouse, his mother also succumbing to it two days afterwards. During the week ending the 21st July Hedge's brother, living at Lower Chapman Street, St. George's-in-the-East (not the first case in that street), was attacked by the epidemic, and his daughter (aged 18 years) died from it in the London Hospital on the 29th July.

The foregoing facts appear to me to preclude the conclusion that the two first recognized cases of the outbreak had been developed, as an intensification, out of a pre-existing state of diarrhœal disease. The cases crop out suddenly, and with an exceedingly sharp definition, among a portion of the population eminently free at the time from the allied class of diseases. They crop out as suddenly, as sharply, as untraceably, as to source, as cases of small-pox or scarlet fever, not unfrequently crop out among sections of the population which have been for some time free from those diseases. And the genetic analogy is, clearly with small-pox rather than with typhus.

The commencing activity of the choleraic poison in Bromley on the 26th June must be looked upon, so far as our present knowledge of the facts extend, as a phenomenon entirely independent of the ordinary summer diarrhœa and cholera of this climate. The history of the outbreak over the whole metropolis in the succeeding fortnight, as already given, shows that Bromley was not the sole centre of early activity of the poison, but that the epidemic quickly declared itself in several widely separated districts. How the poison originated or became disseminated, or more correctly, where the individuals of the resident population earliest attacked first contracted the disease, and in what manner, the known facts do not show. In the case of Hedge and his wife this knowledge died with them, but the presumption is that they contracted the disease (more correctly, perhaps, swallowed the poison) at the same time, and under the same circumstances, circumstances to which they alone of their family, their fellow-workers, or their neighbours, were at that time exposed.

The actual facts helping little towards a complete explanation of the initial phenomena of the outbreak, the only true guide to safe deductions is the whole history of that diffusion of cholera in 1865 and 1866 of which the metropolitan outbreak is but one of the later incidents. Of the early portion of that history, relating to 1865, in which year the chief dispersion of the disease took place, I have had the honour already to report to the Medical Department of the Privy Council.* To this report I would refer for the authenticated facts which throw the clearest

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* See Eighth Report of the Medical Officer of the Privy Council.

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light upon the diffusion of the epidemic. They seem to me to compel the conclusion that the chief agents in the dissemination of the present epidemic have been the sick from the malady in its slighter as well as more marked and characteristic forms: a conclusion, I may add, which has been adopted absolutely of epidemic cholera by the International Sanitary Conference which met last year at Constantinople to consider the question of the preservation of Europe from this pestilence.

The history of the epidemic in its entirety points therefore to the transmission of the disease to the metropolis from localities previously visited by it in Western Europe. It is true that I have failed to discover the links of transmission, but this failure carries little weight, when applied to the population of London, as an objection to the inference. The difficulties in the way of carrying out an investigation of this kind among the immense and widely distributed mass of inhabitants are well nigh insuperable. Of these difficulties, as affecting the present investigation, that of obtaining information concerning the large transitory population in incessant movement between the metropolis and the continent is the greatest, a movement so great that Mr. Simon's dictum that "*Contagions current on the continent of Europe must be deemed virtually current in England,*"* is to be accepted as an axiom in State Medicine.†

§ 2.

Conditions influencing the Progress and Distribution of the Outbreak

(*a*) METEOROLOGICAL STATES.

Meteorology.

The chief meteorological phenomena of the epidemic period have already been summed up by Mr. Glaisher‡ and a comparison instituted between them and those occurring during previous cholera outbreaks. The contrast is remarkable. The visitations of 1832, 1848, and 1854, were coincident with great atmospheric pressure, high temperature (except in 1832‖), small diurnal range (owing mostly to high night temperature), deficiency of rain, very little wind (and comparative stagnation of atmosphere and prevalent mist), a deficiency of electricity (indicated by the few electrical disturbances§), and in 1854 "the presence of a remarkable blue mist" which prevailed night and day.

During the three months of principal prevalence of the recent outbreak in the metropolis (July, August, and September,) the atmospheric pressure was remarkably low. From the 26th of July to the end of the quarter the barometer, reading at the height of 160 feet, never reached the point of 30 in., "a most rare occurrence," Mr. Glaisher writes. The temperature of the air was low night and day, except in September, when the nights were warm. The daily range of temperature was small, "chiefly "owing to low day temperature, particular in August and to a somewhat "less degree in September, but the range in September was still "further lessened by the high temperature of its nights." There was an abundance of rain, and the air was in almost constant motion "fre-"quently blowing a much heavier gale than usual at this season of the

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* 8th Report, p. 43.

† In carrying out the investigation concerning the earliest cases, I had the good fortune to be assisted by the Rev. H. Whitehead, M.A., to whom Medicine is in a great measure indebted for that elaborate investigation of the cholera outbreak in the parish of St. James's, Westminster, (the Broad-street-pump outbreak), which it is now known gives to Dr. Snow's opinion of its origin a probability, practically amounting to demonstration.

‡ Quarterly Return of the Registrar-General, July–Sept. 1866, p. 18.

‖ Appendix to Report of Committee for Scientific Inquiries, Cholera-Epidemic, 1854, p. 114.

§ It is unfortunate that the electrical observations at Greenwich during 1866 were so interrupted as to prevent comparison with observations made in 1849 and 1854.

"year." "Nearly all the circumstances," Mr. Glaisher observes, "are "directly opposite to those mentioned above, as being present at the pre- "vious visitations of cholera, and have probably aided in checking its wider "extension." He adds, "One of the most remarkable atmospheric pheno- "mena during the past quarter has been the prevalence of a peculiar blue "mist, first seen by myself on 30th July, but which had been remarked "by other observers in the preceding week. This blue mist since that time "has been generally present; on some days no trace of the mist has been "visible, and on other days it has been seen for parts of a day only. It "has extended from Aberdeen to the Isle of Wight, and of the same tint "of blue everywhere. This mist increased in intensity when viewed "through a telescope; usually no mist can be seen when thus viewed; "it increased in density during the fall of rain; usually mist rises after "the fall of rain. Its density did not decrease when the wind was blow- "ing moderately strong, but did decrease when a gale was blowing, but "increased again on its subsidence. I do not know the nature of this "blue influence, but the fact of its presence not having been noticed since "the cholera period of 1854 till now points out a possible connexion, "but, independently of this, it is of high meteorological interest."

Mr. Glaisher's observations are restricted to the September quarter. I append a table (XI.) containing the weekly summaries of observations at Greenwich, over the whole period of the outbreak.* The accompanying diagram will render the relationship of the principal meteorological phenomena to the rise, fall, and fluctuations of the mortality from cholera and diarrhœa obvious to the eye.

Two points only require consideration by me in addition to those which Mr. Glaisher has commented upon. The first of these is the probable effects of certain excessive variations in the temperature of the air upon the early, sudden, and large development of the outbreak; the second, the relationship of the fluctuations of the outbreak during its decline to variations of temperature. I may direct attention, however, to the deficiency of ozone during the four weeks in which cholera became active and the outbreak attained its greatest development.

The initial activity and rapid development of the outbreak was preceded and accompanied by an excessive range of temperature.

The mean temperature of the week ending the 30th June, in which the earliest cases of cholera occurred, was 4°·8 above the mean of the same week on an average of 50 years. During the next week the mean temperature fell 5°·1 below this average, but in the following week the mean was in excess 6°·3. In the first and third of these weeks the range of temperature was 24°·0, in the second 17°·5.

The daily variations of temperature in excess or defect of the average of 50 years, during the three weeks, I subjoin:—

——	Difference of Mean Temperature from average of 50 Years.	——	Difference of Mean Temperature from average of 50 Years.
June 25	— 0·4	July 5	— 4·6
„ 26	+ 6·0	„ 6	— 5·2
„ 27	+ 8·0	„ 7	— 6·2
„ 28	+ 8·2	„ 8	— 4·1
„ 29	+ 3·7	„ 9	+ 4·4
„ 30	+ 7·3	„ 10	+ 8·8
July 1	— 3·3	„ 11	+ 7·6
„ 2	— 3·5	„ 12	+ 8·8
„ 3	— 6·6	„ 13	+ 11·1
„ 4	— 6·6	„ 14	+ 7·2

* Extracted from the Registrar General's Weekly Returns.

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It is not improbable that the great range of temperature in the last week of June and the second week of July was influential to some extent in causing the sudden development of the epidemic in other districts than the East during the third and fouth weeks of July and first week of August.

The relationship here suggested between the temperature and the development of the epidemic in the districts referred to is supported by the correspondence between the lagging of the epidemic during its decline, and certain sudden elevations of the temperature above the mean. It has already been shown that the rate of decline of the outbreak was much slower after the third week of fall than in previous epidemics.* The epidemic lagged in fact, and this lagging first followed and partly accompanied a three weeks elevation of the mean temperature slightly above the average, after a four weeks persistent fall beneath it. And it may be here observed that of the four weeks during which the mortality of the outbreak was greatest, and in each of which the temperature fell below the average, two of the weeks were weeks of rapid decline of the disease.

An augmentation of the outbreak in the last week of September and first and second weeks of August, during which the mortality in the metropolis, exclusive of the East Districts, reached its maximum, occurred contemporaneously with a three weeks elevation of the temperature above the average ; and the subsequent fall of the epidemic, near the commencement of winter, contemporaneously with a temperature maintained above the average, was sluggish.

That temperature and meteorological changes played a very subsidiary part in the great development of the epidemic in the East Districts a few moments consideration will show. So far as predisposing the individual to the disease was concerned, their influence was not limited to any part of the metropolis. So far as exaggerating the noxiousness of certain localizing causes of the disease, such as overcrowding, filth, imperfect drainage, &c., these causes were not limited to, neither were they more marked in the East than in several other districts, as for example, Bermondsey and Westminster, in which cholera early appeared. Such influence as atmospheric changes exercised over the progress of the outbreak, must be sought in its general course throughout the metropolis, apart from the disturbance caused by the excessive development in the East Districts. Not that the latter was altogether unaffected by the temperature of the air, its varied states, and the weather, but the manner in which these agencies chiefly operated in fostering the excessive prevalence of cholera in the localities referred to, differed very considerably from their presumed mode of operation elsewhere in the metropolis. The consideration of this question, however, belongs to a subsequent section.

(*b*) ALTITUDE.

Altitude.

Dr. Farr, in his *Report on the Mortality of Cholera in England*, 1848–49, showed that the deaths from the epidemic in the metropolis during that outbreak were distributed, within certain observed limits, "*in the inverse ratio of the elevations at which the people live.*" (p. lxiv.) Upon this relation between elevation and the destructiveness of cholera he remarks, that it "may not be expressed by the same figures "in other places, or in London at other times, but it will always be the "general rule that the *mortality of cholera is in versely as the elevation* "*of the people assailed above the sea-level.*" (p. lxix.) The distri-

* It must be remarked, however, that the climax occurred earlier than in previous epidemics.

bution of the mortality from cholera in relation to elevation, during the outbreak of 1853–54, was generally in accordance with this inference.

In the recent outbreak the deviation from the rule deduced by Dr. Farr has been wide. The mortality from cholera in the lowest-lying districts (under 3 feet above high-water mark) was less than in districts at an elevation of from 3 to 10 feet; the greatest mortality occurred at an altitude of from 10 to 20 feet; the next greatest at from 20 to 40 feet; and the number following in order after this at from 40 to 60 feet. The number last referred to was one-third greater than the mortality at an elevation of from 3 to 10 feet.*

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Elevation in feet above Trinity Mark.	Rate of Mortality per 10,000 population, Metropolis, 1866.	East and North-east Districts.
Under 3 feet	5·8	167
3 — 10	19·2	89
10 — 20	55·4	88
20 — 40	30·5	76
40 — 60	28·9	17
60 — 80	6·2	4
80 and upwards	4·2	0

Notwithstanding this disagreement between the distribution of the total mortality over the entire metropolis in the recent outbreak and the rule of altitude observed in 1848–49 and 1853–54, the dispersion of the deaths in the districts chiefly affected by the outbreak, that is to say, the East and North-East Districts, was strictly in accordance with the rule. In these districts the rate of mortality steadily diminished, without interruption, from the lowest to the highest altitude, and yielded the series 167 (under 3 feet elevation above high-water mark), 89, 88, 76, 17, 4 (at from 60 to 80 feet elevation).

It is noteworthy, also, that during the period of greatest activity of cholera, the rate of mortality of the disease over the entire metropolis, dominated by the undue preponderance of the outbreak in the East Districts, closely approximated to the rule of altitude. During the 10 weeks ending the 15th of September, the rate of mortality formed the following series from the lowest to the highest elevation above high-water mark: 65·82, 33·46, 34·52, 18·86, 5·24, 1·79, 1·49, ·86.†

The anomaly between the general and some special results of the rate of mortality in reference to altitude is striking. It would seem as if a certain degree of intensity of prevalence of cholera in the metropolis is requisite before the mortality follows the law as to elevation unfolded by Dr. Farr. And it becomes a question for consideration whether the masking of this law, by the more general dispersion of the disease over London during its subsidence in the East Districts, may not indicate a leavening of the population, of which the ultimate results, more closely in accordance with previous observation, have still to be experienced.

The mean mortality of the three outbreaks of 1848-49, 1853-54, and 1866, gives the following series from the lowest to the highest elevation: 87, 71, 46, 50, 24, 21, and 10.‡

* This comparison is based upon the calculations of the rate of mortality from cholera given in the Registrar General's Summary of the Weekly Returns for 1866. *See* Appendix, Table X.

† *See* Supplement to the Registrar General's Weekly Return for September 29th, 1866, p. 658.

‡ I take this series as well as other figures in the above section from some careful calculations published in the *Lancet*, January 26, 1867, p. 126.

(*c*) SOIL.

Soil.

Professor Pettenkofer's doctrine.

In all epidemics of cholera in this country, the state of the soil and the degree to which it was charged with moisture and decomposing organic matter, especially excrementitious, has been held to exercise an important influence over the localization of the disease. A doctrine has been advanced as to the relationship of the soil and its nature to outbreaks of the malady, by Professor Pettenkofer, of Munich, of as great importance practically, if substantiated, as Dr. Snow's theory of the frequent propagation of the disease by the drinking water. Professor Pettenkofer maintains that a certain condition of soil is necessary to the development of epidemic cholera in a locality. The soil he holds must be porous, and permeable to water and air. It must possess a particular degree of humectation, depending upon the position of the subsoil water to the surface. It must be charged with organic, especially excrementitious, matter. A soil thus circumstanced he believes to be an essential condition for the development of epidemic cholera. It is the nidus in which, or the condition in conjunction with which, the cholera poison, once finding admission to it, undergoes that development which is requisite for its rapid dissemination among the people living upon the soil. This condition of soil fosters, not develops, the cholera poison. The latter must come from without, and it finds its way into the soil, mainly, by means of the evacuations of the sick of the disease. And the reception is not alone sufficient to its multiplication and further propagation. It is only in a certain state of humectation of the soil that this aptitude to multiplication and propagation occurs ; and this state has a definite relation to the recession of the subsoil water after it has approached unusually near the surface.

Professor Pettenkofer's doctrine is based upon an extended study of the subject, but hitherto perhaps the facts are not sufficiently numerous in proportion to the sources of fallacy, for a conclusive judgment to be given on its validity.*

It had been proposed at the commencement of the present investigation, as one part of it, to examine the outbreak in East London with special reference to Professor Pettenkofer's doctrine. But, unfortunately, the gentleman to whom was entrusted the examination of the water-levels was prevented by illness from carrying out his portion of the inquiry. Illness also prevented me from executing more than my own share, or attempting to carry out more than the facts of the case rendered necessary. And the special investigation of Pettenkofer's views could not, under the circumstances, be included in that category ; for, although the outbreak in East London occurred mainly on the porous gravel on both sides of the river Lea,—the gravel being for the most part surcharged with excrementitious matters, and so in accordance broadly with Pettenkofer's views—the outbreak was limited to only a comparatively small area of this soil, the contiguous portions differing in nowise, for the most part, in levels, state of surface, and of population. Moreover, the line of limitation was marked by a contour as remarkable as defined, and having an obvious relation to houses, not to soils. The outbreak was also virtually contemporaneous over the whole of the area thus limited, and the disease at the time of explosion stopped

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* Mr. Simon has written in reference to this subject, that "the bearing of the "geological influence is apparently none but this—that where populations are living "in certain geological conditions, there, unless engineering science have supplied "artificial drainage and water supply, the local atmosphere and drainage water will "almost certainly be much polluted by those fæcal impurities amid which the "diarrhœal contagia are peculiarly apt to multiply." *Eighth Report, p.* 36.

abruptly short within and along this line of limitation, a line at no point formed by a varying condition of soil.

These facts indicated that the state of soil played a very subsidiary, if indeed any, part in the development of cholera in the East Districts, and directed attention to another and more probable source of the explosion. Indeed the same conditions of soil and surface existed also in many parts of the metropolis, in which there were scattered cases of cholera, but in which no important spread of the infection took place. (*See Map I.*)*

(*d*) DENSITY OF POPULATION.

Density of population.

That packing of the population which acts as a fostering agent of cholera is not shown by the only practicable method of dealing with great masses, the density of people per acre. In the recent outbreak, as in previous outbreaks, there was no relation between the density of the population as expressed by number of persons per acre and the intensity of prevalence of the disease. In Stepney and Poplar, where the outbreak was most fatal, the packing of the population, thus read, is less than in any other of the East Districts. And the most densely crowded district in this neighbourhood, St. George's-in-the-East, is less packed than several of the central districts, as, for instance, St. Giles and the Strand, less even than St. James Westminster and St. George Southwark. (*See Appendix, Table IX.*)

The mean mortality of cholera in the two epidemics of 1848–49 and 1853–54 was 43 per 10,000 population in the three most open districts, 28 in the three most dense districts.‡

(*e*) FILTH.

Filth.

London was unquestionably less filthy at the time of the outbreak than in any previous outbreak. The degree of diminution could only be appreciated by those who were able to compare by experience present with past states. But the East Districts cannot claim a pre-eminence of filth. In the west of the metropolis and south of the river there are many localities as filthy. Neither Rotherhithe nor Bermondsey nor Southwark nor Westminster can be compared favourably with the East of London, yet the three former places suffered in a trifling degree as compared with the latter. Not that filth was altogether inactive; I would imply that its presence was insufficient to explain in any degree the predominance of the epidemic in the East Districts. But filth played a part in propagating the disease in certain blind alleys and contracted courts when the disease found admission to them. And it was probably an important agent in the spread of the malady in Blue Anchor Yard, Whitechapel, as will be seen

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* In carrying out this portion of my inquiry it was my good fortune to obtain the invaluable aid of Mr. W. Whitaker, B.A., F.G.S., of the Geological Survey of England. To this gentleman I am indebted for corrections of the Geological Map and for a series of unpublished notes on the Surface Geology of London, which furnish for the first time the material, hitherto inaccessible, for the Medical Geology of the Metropolitan area. I have not hesitated, therefore, to include these important notes in the *Appendix*, and I would express my warmest thanks to Mr. Whitaker for them.

Mr. Whitaker describes the alluvium of the Thames Valley, including the delta of the Lea, as for the most part clayey, and therefore impervious to water. The alluvial tract east of the river Lea is but very scantily built upon. In Canning Town and Halleville, Mr. Rawlinson informs me, the foundations of the houses rest upon the alluvium. In North Woolwich some rest upon the alluvium, some are sunk to the gravel beneath.

‡ Report of the Committee for Scientific Inquiries, Cholera Epidemic of 1854, p. 12. It must be mentioned, as an exception to the general conclusion in the text, that the Broad Street pump outbreak in 1854 occurred in the most densely-populated sub-district of the metropolis.

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in a subsequent section.* It is true, indeed, that there are certain prominently filthy spots in the East Districts, and Mr. Orton, the Medical Officer of Health for Limehouse, believes that local nuisances played an important part in determining the outbreak in the latter. He writes: "The Lea Cut and Regent's Canal were intolerable during the "hot weather in June, when on one day the thermometer was 165° in "the sun. Then look at Bow Creek, into which was pumping at this "time the sewage of 70,000 inhabitants, including Stratford, West "Ham, and all about Victoria Dock. . . . . Then add to the list "the numerous factories on Bow Common, and more or less throughout "the eastern district, the comparatively stagnant water in the docks, as "well as that charged with organic matter in and about the poorer "dwellings at a low elevation, in some cases only two feet above, and "vast numbers many feet actually below, Trinity high-water mark, and "there is to be found an aggregation of filth, I believe I am not wrong "in saying, not to be equalled by the rest of the metropolis. At this "time the Thames at Greenwich was 68 degrees, so that from a large "tidal stream to stagnant water like the canals, it was probably here at "80 degrees of heat."†

(*f*) Sewerage.

Sewerage.

At the time of the outbreak the East Districts of the metropolis were less well drained than the whole of the south and the greater portion of north-west London. This arose from the low-level sewer of the great main drainage system, into which the first-named districts will discharge their sewage, not being completed. These localities then were less fully freed of their sewage than those which poured their refuse into the lines of main drains already completed. But this defective drainage was not peculiar to the East Districts. It was a defect from which they suffered in common with the City, much of Clerkenwell, the Strand, Westminster, Chelsea, Brompton, part of Kensington, and St. James. (*See Map I.*). Moreover, it was a defect exercising no influence east of the river Lea. It involved only one part of the cholera field, and it was common to that part and several other districts. These considerations preclude the supposition that imperfect drainage from this source could have played any active part in the limitation of the outbreak, although it exercised an important but indirect effect upon its determination, as will be shown in the section on the water supply.

(*g*) Locality.

Locality.

Locality is a vague term, including several of the foregoing conditions, each of which is efficient to an undeterminable extent in bringing about a common result. The influence of locality, thus understood, was apparent, in exaggerating the effect of the outbreak in several restricted districts; but this influence was insufficient to account in any perceptible degree for the peculiar localization of the disease in the East Districts, for which an explanation is sought. Thus from the outset of the explosion in those districts, a combination of local causes gave rise to an exaggerated prevalence of the disease, as compared with

* Mr. Rawlinson has directed attention to the flooding of the cellars of houses in certain parts of Poplar with sewage from an accidental block to an outlet drain in June 1866. I learn from Mr. Cooper, of the Metropolitan Board of Works, that, early in the month, that outlet of the West India Docks Sewer, in the Isle of Dogs, was blocked temporarily, and that the lower parts of the houses and buildings on both sides of Manchester Road were flooded with sewage. An accident also to a penstock about the same time, led to the admission of tidal water into the sewer which drains Blackwall and Poplar, and the consequent flooding of certain premises between the entrance of the West India Docks and the Blackwall Railway.

† Special Report to Limehouse Board of Works on Cholera Epidemic, 1866, p. 4.

surrounding localities in Limehouse, within the angle formed by the Regent's Canal (*See Map I.*). There, at a low altitude, the ground is crowded with ill-built and badly provided cottage-houses, chiefly arranged in long, close streets, abounding in the sanitary defects which too commonly characterise the cottage property of the metropolis, and inhabited by a poor population. It may be surmised, moreover, that the porous soil, exposed to infiltration from the neighbouring canal, possesses a degree of moisture not found elsewhere in the neighbourhood.

f. In London by Mr. Radcliffe.

In Bermondsey cholera only showed epidemic activity, Dr. Wm. Parker, the Medical Officer of Health for the district, states, "at the extreme "eastern part of the parish in a block of small streets, seldom free "from fever or some other zymotic disease, and inhabited by poor "Irish labourers employed at the docks and wharves, whose wives "work at cinder sifting, sack sewing, or in glue and size yards, and "where the children are much neglected."

Water Supply.

(*h*) WATER SUPPLY.

There remains for examination the probable influence of the water supply. Not one of the conditions named in the previous sections, and believed to be liable to affect the progress and development of epidemic cholera, the disease being present, will account for more than very limited fluctuations of the outbreak, or for its localization in any particular spot in a restricted degree only. Any combination of these conditions is, moreover, equally inefficacious in explaining that peculiar localization and fluctuation in the East Districts of the metropolis to the solution of which this report is specially directed.

By a process of exclusion the condition remaining for investigation, the water supply, is thus freed from the principal sources of disturbance which, it is presumable, might most mask its influence upon the outbreak.

From the commencement of the localization of cholera in the East Districts the probable association of this circumscription with an impure water supply was forced upon the mind. The predominant lesson derived from the outbreaks of 1848–49 and 1853–54 was, that the localities of chief prevalence of the disease were mainly, if not solely, determined by the degree of impurity of the water supply.* The application of this lesson to the recent outbreak was not the less compelled by the transference of the chief field of localization from districts south to districts north of the Thames, the former having changed markedly in two respects only in the interval between the recent and preceding epidemics, namely, in the character of their water supply, which was obtained from much purer sources,† and the freer removal of their sewage by the completion of the southern main-drainage works.

* *See* Mr. Simon's *Report on the Cholera Epidemics of London in* 1848–49 *and* 1853–54 *as affected by the Consumption of Impure Water* (1856).

† The great field of activity of cholera south of the Thames in 1848-49 and 1853–54 was supplied by two water companies, the Lambeth and the Southwark and Vauxhall. The former before 1853 drew its supplies from the Thames near Hungerford Bridge, the latter from the Thames at Battersea. In 1848–49 the recipients of the Lambeth company died at the rate of 12·5 per 1,000, the recipients of the Southwark at the rate of 11·8. Before the outbreak of 1853–54 the Lambeth company had removed its source of supply from the Thames at Hungerford Bridge to the Thames at Thames Ditton. When the epidemic again broke out it again localized itself in the districts of former activity south of the Thames, and also prevailed with great violence north of the river, in St. James, Westminster. But the deaths among the recipients of the Lambeth company were only 3·7 per 1,000, whilst the deaths among the recipients of the Southwark company were no less than 13·0 per 1,000. (See *Mr. Simon's Report.*) The unusual prevalence of the disease in St. James, Westminster, it is known was caused by the water of the Broad Street pump. Since 1854 the Southwark company has also obtained its supply from a purer portion of the Thames than the river at Battersea.

During the week ending the 28th July it became obvious that the brunt of the outbreak had fallen upon the East Districts; and in the Bill of Mortality for the week the Registrar General directed attention to the fact that the field of prevalence of the disease was supplied with water from the East London Water Company's works.

Action of Medical Department of Privy Council Office.

On the 1st August Dr. Buchanan was instructed by Mr. Simon at once to place himself in communication with the executive officers of the East London Water Company, and warn them that the character of the outbreak gave reason to suspect that the water supply of the districts must be in fault. Dr. Buchanan was further instructed to communicate with the local authorities of the infected districts, and urge upon them the necessity for an immediate issue of an admonitory notice respecting the preparation and storing of water for domestic use. The notice recommended was as follows :—

CHOLERA.—NOTICE !

> " The inhabitants of the district within which cholera is prevailing are earnestly advised *not to drink any water which has not previously been boiled.*
>
> " Fresh water ought to be boiled every morning for the day's use, and what remains of it ought to be thrown away at night. The water ought not to stand where any kind of dirt can get into it, and great care ought to be given to see that water-butts and cisterns are free from dirt."

Dr. Buchanan was also instructed that if there should seem a chance of any delay occurring in the foregoing suggestion being carried out, he should himself act energetically in Mr. Simon's name, and cause placards to be printed and distributed throughout the districts, so that they might be posted everywhere before daylight next morning.

At the same time Mr. Rawlinson and Mr. Arnold Taylor were requested to inspect, in conjunction with Dr. Buchanan, the works of the East London Water Company, and report on their condition, and on the state of the water, as daily pumped into the districts supplied from them.

The wisdom of these proceedings will appear in the sequel.

Description of the East London Waterworks.

A description of the East London Waterworks is necessary to a right comprehension of much that follows. The Company draws its supply from a loop branch of the river Lea near Tottenham mills, about four miles in a direct line N.N.W. from its works at Old Ford. It has complete control over this branch, and, above its effluence, exercises a limited rule over the main stream and lateral channels to Ponder's End, several miles higher. The river rises in Bedfordshire, passes through Hertfordshire in a south-easterly direction, and ultimately flows into Bow Creek at Bromley. In its course it drains about 570 square miles of country, and before reaching Enfield lock, six miles north of Tottenham mills, it receives the sewage of numerous towns and villages on its banks, housing a population of upwards of 150,000 souls. It receives in its course also, as affluents, several smaller streams, each in its degree a recipient of sewage. At Hertford, the principal town on the banks of the river, the sewage of the town is presumably not poured into the river until after a process of deodorization. The sewage of Enfield and of the parishes of Edmonton, Tottenham, Hornsey, the two Barnets, and Monken Hadley is diverted from that portion of the river over which the East London Water Company has control, by an intercepting drain constructed by the Company. Below the point where the intercepting sewer delivers its contents into the river, a point above Lea Bridge, the stream and its various offshoots become the common sewer of a large mass of the metro-

politan and suburban population, the foulness of the water and its bed augmenting as the Thames is approached, the diurnal flushing of the tide being shut out of the proper bed of the stream by a system of locks requisite to maintain the navigability of the waters. The Lea is a shallow sluggish stream of insignificant proportions, and navigable only in certain parts. It forms a portion of a series of canals along which a considerable trade is carried; but barges do not enter the river above the position of the East London Company's source of supply until five miles beyond Walthamstow.*

The source of supply.

A short distance to the N.W. of Tottenham mills, and of Ferry Bridge on the main stream, the river Lea gives off a narrow branch known as Copper Mill Stream. This branch forms a loop which joins the main stream again, about a mile in a direct line south of Tottenham Mills. From Copper Mill Stream immediately south of the point where it is traversed by the road leading eastwards from Ferry Bridge, water is directly drawn into five subsidence reservoirs, occupying 110 acres of ground, and having an average depth of 11 feet. From the subsidence reservoirs the water is conducted in an open canal to a series of filtering beds at Lea Bridge. The beds are 13 in number, and cover an area of about 12 statute acres, and they are so arranged that one or more can at any time be thrown out of use for the purpose of cleansing the sand, by scraping, from mud and weeds.

The works at Lea Bridge.

The process of filtering is apt to be impeded in the fine summer weather, particularly in July, by the rapid deposit of a slimy matter, which blocks the interstices of the filter. This occurs to a greater or less extent yearly. Out of this slimy matter in August a confervoid growth takes place, and contemporaneously with its appearance the filter-beds recover their action fully. This growth is a long, silky fibre, which extends quickly over the sand and brick sides of the filters. "It felts up, so as to "form a coating which the men call 'blanket,' and as dried in the open "air looks like heaps of old coarse sacking."† This growth is not confined to the filter-beds, but it appears also and is developed with equal rapidity upon the brick sides of the open conduit which conducts the water from the subsidence reservoirs. Mr. Greaves, C.E., the engineer of the Company, states that the growth extended with unusual rapidity in the summer of last year.

The works at Old Ford.

From Lea Bridge the filtered water is conducted by a closed iron conduit to two covered reservoirs, situated on the west bank of the river Lea at Old Ford. These reservoirs communicate with each other, forming one receptacle, the capacity of which is 6,000,000 gallons; and the area at the level of the water, when full, measures $2\frac{1}{2}$ acres.

On the opposite side of the river, on a narrow slip of ground between the Lea and a branch of it known as "Pudding Mill River," are two large uncovered reservoirs occupying several acres of ground. (*See Map III.*) The northern reservoir (of about four acres extent) had, at the time of the outbreak, a communication with the covered reservoirs on the opposite bank of the Lea. The open reservoirs were then also connected with the filtering beds at Lea Bridge by an open and foul conduit, and they sometimes, but not often, received the waste water from them. The impurer contents of these reservoirs have been, but it is averred very rarely, used for distribution in the East London Water Company's district in the event of the filtered water running short from an extraordinary demand occasioned by a fire, or from an impeded action of the filter beds.

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* Mr. Beardmore, engineer of the River Lea Trust, Letter to the Registrar General, *Weekly Return*, Sept. 1st, 1866.

† Messrs. Rawlinson and Taylor's Report.

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f. In London by Mr. Radcliffe.

The district supplied with water from the Lea Bridge Works.

The filtered water is distributed over the district to be supplied from two points, Lea Bridge and Old Ford.

A pump at the filtering beds, Lea Bridge, forces water from thence throughout the day over Lower Clapton, Homerton, Hackney, part of Haggerstone and Shoreditch, the northern portion of Bethnal Green, and probably also of Bow, where that district approaches Hackney Wick, and the north-east corner of Spitalfields (Whitechapel), (*See the district marked B in Map I.*) On the east this district of supply is bounded by the river Lea; on the west it is limited by a line which, starting from the bottom of Stamford Hill, passes to the eastward of Stoke Newington and Shacklewell, runs along the western margin of Hackney Downs, taking the course formerly run by the Hackney Brook as far as the junction of Amherst with Dalston Road. From this point the limit is defined by a straight line running to the extremity of Union Street in the Kingsland Road, and passing to the east of Dalston and Kingsland, but traversing East Haggerstone. The line then continues down the Kingsland Road, and advancing into Shoreditch it includes the houses on the western side of High Street, and some of the courts, and ends at an undefined point in Norton Folgate. The northern limit of this district is not well defined, as the mains communicate with those of Stamford Hill, which is supplied from Old Ford, and the limit to which the water from Lea Bridge is distributed is not uniform, but lies somewhere in a district (*marked* C^1 *in Map I.*) which is bounded on the west by a line which runs from the bottom of Stamford Hill to the middle of Lower Clapton Road; on the east by a line running from the river Lea a little above High Hill Ferry to the same point. This district includes Upper Clapton. The southern limit of the district is, from a like cause, undefined. Here also the mains communicate freely with those of the district altogether supplied from Old Ford, and the limit oscillates, according to various circumstances of pumping, between two lines, the northern one extending from the upper extremity of Norton-Folgate to the southern limit of Hackney Wick, the southern from Artillery Passage, Spitalfields, to Old Ford Locks. (*See district* C^2 *in Map I.*)

The district supplied with water from the Old Ford Works.

The other point from which water is distributed is the Old Ford covered reservoirs. Here several powerful engines force the water over a district which occupies a large area east as well as west of the Lea. West of the river (*See district A in Map I.*) the northern boundary falls somewhere within the district (*Map I*, C^2), inside which the southern limit of the district supplied from Lea Bridge is lost. The western limit is defined by a line which includes the west side of Bishopsgate Street Without as far as Sun Street, and then crosses to Union Street, passes obliquely across Artillery Street, and is continued to the left of Sandy's Row as far as the southern side of Artillery Passage. It next passes from east to west south of the Passage and Raven Row as far as Hill Street; then keeping to the westward of this street, and of Cox's Square, it takes a course intermediate between Short Street and Middlesex Street; as far as New Goulston Street. Avoiding the latter street, and keeping to the north of it, the line next passes along and includes the west side of Goulston Street, then crosses Whitechapel Road and Somerset Street, includes the west side of that street and Little Somerset Street, and also passes along the west side of Mansell Street, Goodman's Fields. From Mansell Street the line runs south to Little Prescot Street, which it passes round, then going eastward along the line of the Blackwall Railway for a short distance, it again turns south, and traversing the courts east of but immediately adjoining Blue Anchor Yard, it enters East Smithfield, ending at Sun Court. To the south this district is limited by the line of the Thames.

Within the area thus bounded are included a fractional part of East London, the greater portion of Bethnal Green, all Whitechapel, with the doubtful exception of the north-west corner of Spitalfields, St. George's-in-the-East, Stepney, Mile End Old Town, Limehouse, Poplar, Bromley, and Bow. North of this area a main (now disused) is carried from Old Ford for the supply of part of Lower Clapton, the whole or greater part of Upper Clapton, and the whole of Stamford Hill.

East of the river Lea the Old Ford reservoirs supply an area defined by a line which, commencing in the north, runs eastward from the river to Cut-through Lane, New Stratford, passes along this lane to the commencement of Chestnut Walk, and is then prolonged to the "Rising Sun" inn on the Romford Road. From this point it turns sharply south, runs to the east of Upton Lane, of Plaistow, and of Prince Regent Lane to the Victoria Docks, and thence eastwards to North Woolwich. Within this line are included Old and New Stratford, Forest Gate, West Ham, Plaistow, Canningtown, Halleville, Silvertown, and North Woolwich.

Throughout this area the East London water supply predominates, although in West Ham and Plaistow it is still to some extent supplemented by wells. Canningtown, Halleville, Silvertown, and North Woolwich, are entirely, Stratford chiefly, supplied by the Company.

Beyond this area mains are carried from Old Ford, north of Stratford, to Epping Lower Forest, Wanstead, Leyton, Leytonstone, Walthamstow, and Buckhurst Hill, but a comparatively small number of houses are supplied with water in the localities named.

Population and number of houses supplied by the East London Water Company.

The population included within the whole area supplied by the East London Water Company is upwards of 700,000, the number of houses 99,000. The water, as a rule, is accessible each day for a period of about 30 minutes, but many streets and houses have a continuous supply, and this mode of service is preferred by the company, and is being commonly adopted in new houses. The Old Ford reservoirs are pumped from only during the day; at night the entire series of mains is filled from Lea Bridge.

Relationship between area of explosion of cholera in the East Districts and water supply.

This description of the East London Water Company's district being premised, I am now in a position to show the relationship which existed between the area of excessive prevalence of cholera in the East Districts of the metropolis and adjoining suburbs and the area of distribution of the water supplied exclusively by one particular company to those districts.

1. It has already been shown that the explosion of cholera in the East Districts took place between the 11th and 21st July. It has also been inferred, from the rate of increase of mortality, as compared with the previous week, having in the week ending the 28th July become nearly the same in the East as in other districts of the metropolis, that the determining cause of the explosion, whatever this might be, had probably ceased to act during the week ending the 21st of the month. It follows that the distribution of the mortality from the 14th to the 21st July will most clearly indicate the area of explosion. I have already described this distribution with reference to the general history of the outbreak. I have now to recur to it so far as is necessary to explain its relation to the water supply.

Before the 17th July the predominance of the outbreak in the East Districts was marked. From the 11th to the 16th, inclusive, cholera had appeared in every part of these districts, from the river Lea on the east to Mansell Street, Goodman's Field's, and Raven Row (Spitalfields) on the west; and from the line of the Thames on the south to Wellington Place (Bethnal Green) and Three Colts Street (Victoria Park*) on the north.

* Three Colts Bridge, leading from the Old Ford Road and Three Colts Street, is one of the south entrances of the park.

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Within the boundaries thus indicated the disease was scattered in every district.

During the five days but one death from cholera had been recorded in the district north of Bethnal Green and Bow (Hackney); and in the districts immediately west of Whitechapel and Bethnal Green, four deaths were registered—two in the City and two in Shoreditch.

Any doubt which may rest upon the relationship of these cases to the predominance of the outbreak in the East Districts vanishes before the course of the epidemic from the 16th to the 21st July. During this period only three deaths from cholera occurred in Hackney, three in Shoreditch, and one in the City, while the disease in the East Districts underwent its great development as compared with the rest of the metropolis. And there is this that is remarkable in this development, that it is strictly confined to the limits within which the disease had appeared up to the 16th July, with one exception. The exception is, that in the north-west (Bethnal Green) the epidemic had extended its area from Wellington Place a little northwards to the Hackney Road.

Area of explosion approximated closely to area of district supplied with water from Old Ford.

It is seen, then, that to this point the explosion is limited to districts supplied entirely with water by the East London Company, and not only so, but to a restricted portion of the districts so supplied. Further, if a line, starting from Rose Court,* East Smithfield, where the disease had now appeared, be drawn around the area of explosion, so as to include the outlying cases, it will be found to approximate with remarkable closeness to the limits of the districts supplied with water from Old Ford (*See Map I.*)

In the northern districts, receiving water from the East London Company, and with one comparatively small exception from Lea Bridge, the number of deaths from the epidemic within this period was 4; in the southern districts receiving water from Old Ford, the deaths from the epidemic were 391.

But the explosion was not limited to the metropolitan districts immediately west of the river Lea. It extended also, occurring contemporaneously, to the suburban districts immediately east of that river. On the 12th July cholera broke out in Canningtown and Plaistow, on the 13th in Stratford, and before the 21st it had invaded the whole of Old and New Stratford to the north, Forest Gate leading to Epping Lower Forest to the north-east, West Ham in the centre, Plaistow and the conterminous portion of East Ham to the east, and the new town (Halleville) springing up, mushroom like, to the east of Bow Creek and the vicinity of the Victoria Docks to the south.

Now there is but one condition generally common to these localities and the East Districts of the metropolis, namely, the water supply; and it is a fact as remarkable as suggestive that a line drawn along the outer limits of the explosion east of the Lea, to the date under consideration, approximates well nigh as closely as the like line west of the Lea to the limits of the eastern area supplied by the East London Water Company from Old Ford.

The explosion, in fact, was confined to an area supplied with water by one particular company and from one particular source. Whether this relationship was accidental or otherwise has now to be considered.

Relationship between area of explosion and area of Old Ford water supply not

2. London is divided into 37 registration districts. Of these, *five* are supplied wholly, and *four* partially, by water from the East London Company's works. Of the five districts receiving their entire supply from this source, four derive it from the reservoir at Old Ford, namely, St. George-in-the-East, Stepney (Limehouse), Mile End Old Town, and

* Rose Court is the last court but one supplied by the East London Water Company, in East Smithfield, and, with the exception referred to, the extreme south-west limit of supply.

Poplar, and in these four districts the rate of mortality from cholera (per 10,000 population) was respectively 87·9, 107·6, 67·7 and 90·8. In the fifth district, Bethnal Green, the northern and north-western portion of which is commonly supplied from Lea Bridge, and the remainder from Old Ford, the rate of mortality was 60·4.

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The four districts partially supplied by the East London Water Company are Whitechapel, Shoreditch, East London, and Hackney. A very limited portion of Whitechapel, on its western edge, is supplied with water by the New River Company; the rest of the district receives its water from Old Ford. In Whitechapel the mortality from cholera was 84·0. A very small segment of Shoreditch is supplied by the East London Company, and the supply probably comes entirely from Lea Bridge. The remainder of the district derives its water from the New River Company. Shoreditch only lost 10·7 per 10,000 of its population from cholera. The East London registration district is mainly supplied by the New River Company, but the East London Company (with water probably from Lea Bridge) intrudes into the St. Botolph subdivision of the district. The rate of mortality from the disease in the entire district was 15·7.* The Hackney district is supplied mainly by the East London Water Company, partially by the New River Company. The supply from the East London Company, with the exception of a small area at Stamford Hill, Upper and Lower Clapton, is derived from Lea Bridge. The rate of mortality in this district was 10·6.

accidental, shown by distribution of mortality;

In the remaining registration districts the highest rates of mortality from cholera were 19·5 in Greenwich and 11·8 in West London; the lowest rates, 0·8 in Hampstead, 1·7 St. George, Hanover Square, and 2·8 Newington.

Writing of the first six weeks of the outbreak on the 18th August, the Registrar-General institutes a comparison between the mortality in the registration districts supplied with water from Old Ford and the rest of the metropolitan districts. He says, "Six districts are supplied "from Old Ford, and every one has been ravaged by the epidemic; the "other 31 districts have for six weeks in succession suffered slightly. "The 37 districts are subdivided into 135 sub-districts; 21 are sup- "plied with the same water, and have all suffered six weeks in succes- "sion; 115 sub-districts have suffered inconsiderably. . . . By the "doctrine of chances, it is impossible that the coincidence between this "particular water and the high mortality should be fortuitous in 135 cases "during six weeks in succession. The force of this induction," the Registrar-General adds, "extends over all the area of observation in "previous epidemics, where sewage water has so often led to cholera "outbreaks."

The water supply was the only condition common to the whole area of explosion in the East and conterminous suburban districts of the metropolis which experience had taught to be effective in determining violent outbreaks of cholera in circumscribed localities. It was the only condition, moreover, which seemed reasonably to explain the sudden and virtually contemporaneous occurrence of the explosion in all parts of the district. I have now to examine whether the inferences arising out of the mode of explosion of the disease, and the correspondence of the field of prevalence with the area of a particular supply, derive support from the observed facts of the outbreak.

* The total deaths from cholera in East London were 59, and of these 46 took place in St. Botoloph. Two of the deaths only, Dr. Letheby, the Medical Officer of Health for the City of London, informs me, occurred in the houses supplied with water by the East London Company, both in the same house. The first death in this district took place on the 22nd, the second on the 25th July; the former after nine, the latter after 12 hours' illness.

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That the circumscription of the explosion by the limits of the Old Ford supply was not an accidental phenomenon is, I think, proved, by two series of facts, the one taken from the extreme east, the other from the extreme west of the area of prevalence.

by the outbreak in East Ham parish;

Cholera broke out in the parish of East Ham on the 19th July. It was exceedingly fatal in certain most wretched rows of cottages known as King Harry Row (in which it first appeared), Sun Row East, and Sun Row West. Later in the outbreak a few scattered cases appeared elsewhere in the parish. Now the East London Water Company's supply from Old Ford extends into East Ham at one point only, and here it is distributed solely to two separate houses (the "Rising Sun" inn and "Potato Hall") and two rows of cottages. The cottages are those known as "King Harry Row" and "Sun Row East." The inhabitants of Sun Row West also freely use the water as the only dependable source of supply within reach.*

also in West Ham parish;

East Ham is in the registration district of West Ham. The parish of West Ham, according to the books kept by the East London Water Company, contained at Christmas, 1866, 8,739 houses, of which 8,106 were supplied with water by the company from Old Ford, and 633 derived their water from other sources. As clearly as can be determined by the facts accessible, 178 deaths from cholera and diarrhœa took place in the parish of West Ham during the eight weeks ending the 1st September. Of these deaths, 169 occurred in houses supplied with water from Old Ford, five in houses presumably obtaining their water from other sources, and four in houses of which the source of supply was doubtful. In the field of the Old Ford water supply the deaths from cholera and diarrhœa were at the rate of 20 in every 1,000 houses; in the field drawing its water from other sources the death-rate from cholera and diarrhœa was 7 in every 1,000 houses.

and in Whitechapel.

The facts from the western limits of the water supply are almost equally conclusive. Whitechapel is supplied entirely with water from Old Ford, with the exception of the north-west corner of Spitalfields, which probably derives water from Lea Bridge (and which may be excluded from consideration), and a narrow strip on its western border which receives water from the New River Company. The comparative prevalence of cholera among the segments of the population receiving their water supply from different sources have been carefully studied by Mr. Liddle,† the Medical Officer of Health for the district, and with the following results:—

On the 14th August 1866, Mr. Liddle caused a house-to house visitation to be made of Petticoat Lane on the west boundary of his district, and differing only from other portions of the district in the immediate neighbourhood by the character of its water supply derived from the New River Company. The houses visited numbered 193, containing a population of upwards of 2,000 souls, and in these four cases of diarrhœa were alone discovered. In the rest of Mr. Liddle's district, supplied, with

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* The inhabitants of King Harry Row and Sun Row East are supplied from stand-pipes, one of which is placed behind each row of houses. The water supply is constant. The inhabitants of Sun Row West presumably obtain their water from an adjacent common pump, but in reality from the stand-pipe of Sun Row East. The houses constituting these rows and their appurtenances are miserable beyond measure, and, as a rule, are barely fit for human habitations. The inhabitants are most impoverished. These cottages stand alone in their wretchedness among the dwellings in that locality supplied with water by the East London Company.

† *See* Mr. Liddle's Report on the Epidemic of Cholera in the Whitechapel District, 1866, pp. 37, 38, &c.

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a few exceptions, by water from Old Ford, there were discovered the same day 245 cases of diarrhœa, 14 cases of choleraic diarrhœa, one case of diarrhœa passing into cholera, and 22 cases of cholera. These cases were new cases found that day in the course of house-to-house visitation, and they were exclusive of a large number of cases of diarrhœa for which relief was sought at the houses of the medical visitors. On one side of a line defined only by a difference of water supply, the conditions of population as to comfort and hygienic state being in all other respects analogous, there was found an epidemic actively prevailing, on the other hardly an indication of its existence.

The population of Whitechapel supplied by the New River Company numbers 9,224, among whom, during the outbreak, 30 deaths from cholera took place. The population of the district supplied with water from Old Ford amounts to 68,732, and of this number 536 died from cholera, exclusive of deaths of non-residents in the London Hospital. Out of every 1,000 of the population drinking New River water three died; out of every 1,000 drinking water from Old Ford, seven died. And this remarkable difference took place among two sections of a population living side by side, and intermingling to a great extent, the less affected being exposed in the highest degree to accidental infection from the most affected.

Of this liability to accidental infection an instructive instance is supplied by the outbreak of cholera in Blue Anchor Yard, a locality in Whitechapel supplied with water by the New River Company. This yard had at one time an infamous reputation for filth and misery; and notwithstanding the incredible efforts of Mr. Liddle to ameliorate the condition of the population and maintain them in a better sanitary condition, the yard is still notorious for its insanitary state, and for the poverty and precarious subsistence of its inhabitants. The first death occurred in Crown Court, leading out of this yard, on the 26th July, and the brunt of the outbreak fell upon this court. Crown Court contains a population of 966 souls packed into an area of 1,644 square yards. It is a narrow alley leading from Blue Anchor Yard into Glasshouse Street, and the houses have no opening but into the alley. The whole court draws its water supply from a single tap which communicates with a large closed cistern of stone, the latter placed in a small back yard, devoted also to the privies and dust heap. This back yard has a communication with a little court leading out of Glasshouse Street, and which is supplied with water from Old Ford.

Since the 16th July cholera had been prevailing in the immediate vicinity of Crown Court, and on the 22d and 25th deaths from the disease had taken place in Swan Court, Glasshouse Street (receiving water from Old Ford), immediately contiguous to Crown Court. Of the history of the first case in the latter court nothing is known, but the disease once having gained admission it spread with great rapidity and carried off 14 persons.

It is obvious that this outbreak, occurring 10 days after the appearance of cholera in Goodman's Fields, and following upon deaths from cholera in neighbouring courts, affords no serious ground for objection against the theory that the water from Old Ford was pre-eminently concerned in determining the explosion of the disease in the East Districts. Crown Court had been exposed to the transmission of cholera from neighbouring localities, and it offered peculiar facilities for the propagation of the disease.

The foregoing facts from the history of the outbreak in East and West Ham and in Whitechapel seem to me to set the question beyond doubt that the correspondence of the area of explosion with the area of water supply from Old Ford was not an accidental circumstance.

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The absence of a defined limit to the water supply distributed from Old Ford to the north of Bethnal Green and Bow does not militate against this conclusion. For the upper limit of the area of explosion falls, with few exceptions, within the district which is admitted to be common to both the Old Ford and the Lea Bridge supplies, and in which the predominance of the one or the other differs at different times.*

Having shown reason for the conclusion that the correspondence between the area of water supply from Old Ford and the area of the cholera explosion in the East Districts and suburbs was not accidental, I propose to inquire next whether the chronological phenomena of the explosion agree with known facts of choleraic poisoning through the agency of water.

I have shown that the explosion took place between the 11th and 21st of July, and that it is in the highest degree probable that the agent determining it effected its work within that interval. This would give a period of 11 days within which the determining cause would exercise and exhaust its direct activity, the subsequent progress of the outbreak being governed by the same laws as governed the progress of the disease in the rest of the metropolis.

Chronological phenomena of the explosion in the East Districts compared with those of the outbreak at Theydon Bois in 1865.

The outbreak of cholera at Theydon Bois, in Essex, in the autumn of 1865, throws a direct and important light upon this question. In that instance, a family of 11 members, including a visitor and a maid-servant, a labourer and boy assisting in the house, but not sleeping there, were subjected to a frightful outbreak of choleraic disease under the following circumstances. The head of the family and his wife, after a fortnight's absence, had returned home from Weymouth by way of Southampton, cholera having appeared in the latter town eight days before. The day after reaching home the wife was seized with diarrhœa. The husband also suffered from more or less looseness of the bowels, left after an attack of vomiting and purging which he had undergone about thirty-six hours before leaving Weymouth. Both used a watercloset on the first floor, between the soil-pipe of which and the well supplying the house with drinking water there was (as subsequently discovered) free communication. The water tainted with the diarrhœal discharges was used by the family, and the man and the boy mentioned, for five full days, during and subsequent to which several of the members were attacked with malignant cholera, in the following order :—

WATER IN USE.

On the second day of the water's pollution - - -	1
On the fourth „ „ - - -	2
On the sixth „ „ - - -	1

WATER DISUSED.

On the 11th from pollution and fifth after disuse - -	2
On the 12th from pollution and sixth after disuse - -	3

In addition, three cases occurred among individuals who had not consumed any of the water, but had been in communication with the sick; two members of the family (the oldest and the youngest daughter) and the visitor, although using the water as the rest of the family, escaped with slight gastric disturbance; and the youngest son, 12 years of age, did not suffer from any indisposition whatever. It was doubtful whether the

* The limits of this district are so ill-defined, that in the first instance, on information derived from Mr. Greaves, the engineer of the East London Water Company, they were drawn more to the north. In this position the upper limits of the area of explosion fell entirely within the district. The subsequent correction was made under the superintendence of Mr. Greaves.

gastric discomfort of the two daughters and the visitor arose from the water, or from the anxiety and trouble occasioned by the rapid series of attacks and deaths. For, of the twelve cases, nine ended fatally, including the head of the family and his wife.*

Applying these facts to the elucidation of the East London outbreak from the 11th to the 21st July, it is seen that there is a general correspondence between the chronological succession of phenomena. In both instances, assuming that the medium of choleraic poisoning was the same, the direct action of the poisonous agent, although manifested in some individuals after a brief period, was not shown in others until after a lapse of several days. And, in both instances, within this interval of time, the chief effect of the morbific agent was not produced at the beginning but at the end.

The comparison justifies the assumption that both outbreaks were determined in a similar manner.

The chronological phenomena of the explosion in the East Districts coincide sufficiently with those of the outbreak at Theydon Bois to justify the assumption that it may have been determined in a similar manner. The comparison between the two outbreaks may therefore be pushed further. At Theydon Bois the earliest cases (omitting from consideration the first case, as of doubtful relationship to the polluted water) occurred on the fourth day after the use of the polluted water. It is not necessary to assume that the influence of water polluted in a like fashion would, in the East Districts, be manifested at an earlier period. It is to be presumed, indeed, from the undoubtedly less degree of pollution in the one case than the other, that in the latter districts the earliest effects might not be manifested until a somewhat later date.† At Theydon Bois the effects of the morbific agent persisted five days after the disuse of the medium in which it was swallowed. It is not necessary, indeed it is contrary to known fact, to assume in the East London explosion that the use of the poisonous medium was co-extensive in point of time with the direct and manifest activity of the morbific agent. It is most probable that the ingestion of this agent would cease some days before the cessation of its direct effects. The outbreak at Theydon Bois, so far as determined by the polluted water, extended over eight days from the first case, and 12 days from the impregnation of the well-water with diarrhœal discharges, and its use so contaminated. Or, taking the periods of death as the most accucurate mode of comparison with the East London explosion, the outbreak at Theydon Bois extended over 12 days from the first death to the last (excluding a fatal case of relapse, and a protracted fatal case of exhaustion in an old lady 87 years of age), and 15 days from the pollution of the well. The corresponding period of outbreak in the East London district has been inferred to extend over not more than 11 days. At Theydon Bois the polluted water was used fully four if not five days. If the comparison I have made between this outbreak and the explosion of cholera between the 11th and 21st July in the East London districts holds good, it is not necessary to assume that polluted water was consumed by the population of the latter for so long a period.

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* Eighth Report of the Medical Officer of the Privy Council, pp. 48 and 438.

† The degree of pollution may be the explanation of the apparent contrast between the consequences of the Theydon Bois outbreak and that in connection with the Broad Street pump in 1854. The first cases of the latter outbreak occurred on the third, or at the furthest on the fourth day after the beginning of the special pollution of the well in that street. But the Broad Street outbreak, unlike that at Theydon Bois, almost immediately reached its climax, and then, after raging virulently for two days, continuously declined. It is certain, however, from the known facts of the case, that the Broad Street water was subject to a special pollution, however intense, of only 48 hours duration; and it must rapidly, by reason of the very large number of its consumers, have returned to its normal condition.

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An apparent objection to the assumption.

But it must be noted that the actual mortality from cholera in the East Districts went on increasing from the 21st July, with a slight fluctuation, until the 31st of the month (*See Appendix Table VIII., and margin*). The greatest mortality from the disease, indeed, took place during the week ending the 4th August. This fact notwithstanding the different ratios of augmentation of the mortality in the weeks ending the 21st and 28th July and 4th August, as compared with the previous weeks, seems to be inconsistent with the conclusion that a special fostering cause of the disease was in action during the former week only. The facts ascertained do not admit of more than a broad comparison of the explosion with previous outbreaks occasioned by the dissemination of the cholera poison in the drinking water, but it must not be too hastily assumed that the discrepancies militate against, although leaving a flaw in, the conclusion that the poison thus dispersed was the cause of the explosion in the East Districts. This explosion took place at the very outset of the epidemic. The Broad Street pump outbreak took place at the culmination of the epidemic of 1854. The Theydon Bois outbreak occurred when there was no general diffusion of the epidemic, and at a later period of the year than the last-named outbreak. The explosion of cholera in the East Districts in 1866, indeed, took place in the middle of July; the outbreak in connection with the Broad Street pump occurred on the 1st and 2d of September; the outbreak at Theydon Bois from the 28th September to the 6th October. The daily returns of mortality for the East Districts are consistent with the assumption that, as in the Theydon Bois case, the inflence of the presumed polluted water was distributed over several days. It is not inconsistent with the facts further to assume that this polluted water determined for a brief time an exceptional prevalence of cholera, and localized this prevalence within a particular area, and that the subsequent course of development and decline of the disease was not governed by the action of this temporary cause, but by the same laws which governed the rise and fall of the malady elsewhere in the metropolis. The facts, however, may admit of another interpretation, as will be shown in a subsequent section.

Deaths from Cholera.
East Districts, Stratford and West Ham.

July	11	3
,,	12	6
,,	13	12
,,	14	11
,,	15	12
,,	16	31
,,	17	54
,,	18	59
,,	19	83
,,	20	91
,,	21	104
,,	22	104
,,	23	130
,,	24	144
,,	25	166
,,	26	155
,,	27	125
,,	28	157
,,	29	151
,,	30	141
,,	31	171
August	1	170
,,	2	155
,,	3	114
,,	4	112
,,	5	119
,,	6	115
,,	7	84
,,	8	93
,,	9	91
,,	10	72
,,	11	67

It has been suggested that the course of the outbreak in the East Districts is consistent with the supposition that there was a progressive diminution, extending over several days, of the poisonous agent in the suspected water, and consequent proportionate decrement of its ill effects. Dr. Farr has stated the formula for resolving the problem of the decrease of a zymotic poison, such as cholera, under circumstances similar to those assumed to exist in the Old Ford covered reservoirs at the time of the explosion.* This question will be again referred to.

Polluted water distributed from Old Ford

2. I have shown that the limitation of the explosion in the East Districts of the metropolis and their suburbs to the area supplied by water

* Registrar-General's Weekly Returns of Births and Deaths in London, Sept. 15th, 1866, p. 550.

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immediately prior to the outbreak.

from Old Ford was not an accidental circumstance, but that it was clearly in some way or other connected with the water supply. I have shown also that the phenomena of the explosion coincided remarkably in chronological sequence with one of the best defined examples known of a cholera outbreak determined by water polluted with diarrhœal discharges. I have now to examine the question whether at the time of or immediately preceding the explosion polluted water was circulating in the mains ramifying from Old Ford, and was consumed by the population deriving their water from that source.

It was evident that the filtered water distributed from Lea Bridge to the Hackney district prior to and at the time of explosion in the more southern and eastern districts supplied by the East London Water Company was above suspicion. It was clear also that if filtered water from Lea Bridge, stored in the Old Ford reservoir, had, as customary, been distributed without interruption in the infected districts, no imputation would hold good against its character. Bad as the river Lea is above the source from which the East London Company draws its supply, it was undoubted that this stream could not have exercised any direct effect in producing the explosion. For all the localities receiving water directly from the filtering beds at Lea Bridge escaped the explosion.

If, then, the water from Old Ford had become polluted, the source of contamination must be looked for at Old Ford itself; and suspicion at once attached to the open reservoirs filled with unfiltered and impure water, on the east bank of the river opposite the covered reservoirs. The time of the explosion of cholera was the period of the year when the filter beds did their work with most difficulty. The northern open reservoir had a communication with the covered service reservoirs. Assuming that the supply of filtered water had become defective about the close of June or commencement of July, had the company filled up the deficiency by drawing upon the uncovered reservoirs? There were some facts which tended to the conclusion that water had been taken from this source and distributed in the company's mains from Old Ford.

In June eels were found in the supply pipes of more than one locality receiving its water from Old Ford. An eel was removed from the supply pipe of a house in the Bow Road as early as the second week in June.* Now eels are not known to exist in the covered reservoirs at Old Ford, but they abound in the uncovered. It was to be concluded, then, (as the most reasonable explanation of this phenomenon) that the uncovered reservoirs had been drawn upon at least some time prior to the second week in June; and this conclusion being admitted it was the less difficult to assume that they might have been had recourse to in order to supplement a defective supply from Lea Bridge late in that month or early in July. This assumption proves to be the fact.

It has been stated to me by Mr. Greaves,† the engineer of the Company, that at "the close of June or beginning of July, late in the "former month or early in the latter, *water was drawn from the northern* "*uncovered reservoir into the covered reservoirs to the depth of three* "*inches to supplement a defective supply from the filter beds.*" Since this statement was made it has been ascertained and stated in evidence before Captain Tyler, R.E., during an investigation concerning the East London Water Company's works and supply, conducted by that gentleman for the Board of Trade,‡ that in 1866 water was drawn for use from the northern uncovered reservoir once in March, once in the latter part of June, and once in the early part of July. The actual quantity

* *See* the Registrar-General's Weekly Return, Sept. 1st, 1866, p. 457.
† 11th February 1867.
‡ *See* Capt. Tyler's detailed Report (p. 7) published after the close of the present inquiry.

taken from the uncovered reservoir, each time, Mr. Greaves estimates at 300,000 gallons, one-thirtieth part of the day's supply. The dates when the uncovered reservoirs were drawn upon cannot, unfortunately, be stated with more precision than in the words I have given, as no memorandum is kept at the Company's works of the times when a defective quantity of filtered water has been thus supplemented.*

The fact is, however, certain that immediately prior to the explosion of cholera in the East Districts of the metropolis and their suburbs, an impure and unfiltered water was distributed to the infected localities for the domestic use of the population.

Probability that the polluted water contained cholera poison.

3. But it is not sufficient to show that impure water was distributed from Old Ford immediately before the explosion of cholera in the district of supply to account for that explosion. To whatever extent impure water may predispose to cholera, I am not aware of any facts which would justify the conclusion that water loaded with ordinary organic impurities will, under certain circumstances of temperature and locality, determine outbreaks of a specific disease. Observation and research, alike tend to the conclusion that epidemic cholera has a peculiar contagiousness of its own, through and by which the disease alone spreads. The manner in which this property of contagiousness operates has been set forth in words so incisive and so pertinent to the remaining portion of my task, in an Official Memorandum of Mr. Simon, dated July 1866, that it would be folly for me to substitute for them other words of explanation.

"It appears to be characteristic of cholera," Mr. Simon writes, "not only of the disease in its devoloped and alarming form, but equally of the slightest diarrhœa which the epidemic influence can produce—that *all matters which the patient discharges from his stomach and bowels are infective*, that the patient's power of infecting other persons is represented almost or quite exclusively by those discharges; that they, however, are comparatively non-infective at the moment when they are discharged, but afterwards, while undergoing decomposition, acquire their maximum of infective power; that if they be cast away without previous disinfection, they impart their own infective quality to the excremental matters with which they mingle, in filth, sodden earth, or in depositories and conduits of filth, and to the effluvia which those excremental matters evolve; that if the infective material, by leakage, or soakage from drains or cesspools, or otherwise, gets access, even in the smallest quantity, directly or through porous soil, to wells or other sources of drinking water, it can infect in the most dangerous manner very large volumes of the water."

Was the water stored at Old Ford exposed to a process of choleraic contamination such as that described by Mr. Simon? This is the question which remains to be answered, and which unanswered will still leave the origin of the explosion in doubt.

Liability of reservoirs at Old Ford to soakage from the river Lea.

I have already described the position of the reservoirs at Old Ford, the covered service reservoirs on the west bank of the Lea, the uncovered reservoirs on the east bank, and between the Lea and Pudding Mill rivers. The service covered reservoirs were constructed in 1809; they are hollowed partly out of clay, partly, and towards the river, out of less tenacious earth, and are lined with brickwork at the sides. The uncovered reservoirs were constructed in 1826; they are hollowed out of gravel, and are lined partly with Kentish ragstone,

* When the northern uncovered reservoir was drawn upon late in June and early in July, Mr. Greaves was from home. He speaks therefore not from his own knowledge, but from information derived from his foreman. It is not improbable, therefore, that other facts respecting the water supply late in June and early in July, as necessary to a full elucidation of the epidemic, as the wanting dates, have yet to be elicited.

partly with brickwork. The bottoms of both the covered and uncovered reservoirs are formed by the natural earth in which they are made. The depth of the covered reservoirs in relation to the river is in one about 12, in the other about 13 feet below Trinity High Water mark, and when filled the water stands in them about two feet above Trinity High Water mark. The least distant point of the east covered reservoir from the river is 40 feet, of the west 33 feet.

The southern uncovered reservoir is separated from the Lea by a bank of about 50 feet breadth at the summit and 200 feet at the base, and from Pudding Mill river by an embankment of about the same breadth, but interrupted in the middle by a sluice. The northern uncovered reservoir is separated from the Lea for the most part by a bank of about 25 feet breadth at the summit and 100 at the base. The soil in which the uncovered reservoirs are sunk exposes them largely to soakage, other circumstances being favourable, and the better placed and constructed covered reservoirs do not altogether escape this danger. Both the covered and uncovered reservoirs were originally formed for the reception of water direct from the adjacent portion of the river by sluices opened at high water, and when the question of soakage did not require consideration.

On an inspection of the covered reservoirs, which had been emptied as far as practicable for the purpose, on the 24th February 1867, Captain Tyler, R.E., discovered a spirt of water into one reservoir at the site of an old sluice formerly communicating with the river. He found also numerous spirts issuing from the interstices of the brickwork over a portion of the north slope of the east reservoir, measuring from 210 to 215 feet in length; and in more than one spot he observed the surface of the thin layer of water covering the bottom of the reservoirs bubbling from jets of water springing from the ground beneath. An analysis was made by Dr. Letheby of water taken from different spirts, also of water gathered at the close of Captain Tyler's inspection from the bottom of the reservoirs. The results of the analyses are given below.* They show, I think, in each instance that the water had percolated wholly or in great

* *Composition of Special Samples of East London Water Company's Water. By Henry Letheby, M.B.*

Label of Sample.	Old Ford Main.	Old Ford uncovered Reservoir.	Water in covered Reservoir at end of Capt. Tyler's Inspection.	Spirt from wall, site of old Sluice.	Spirt from slope, north end, covered Reservoir.
Date of sample	Aug. 9, 1866	Aug. 9, 1866	Feb. 24, 1867	Feb. 24, 1867	Feb. 24, 1867
Colour 2-foot tube	Green, No. 1	Green, No. 2	Brown, green, 2	Yellow, green, 2	Yellow, green, 1
Odour when heated	None	None	None	None	None
Total solid per gallon	17·93	18·46	22·5	30·0	24·9
Of which loss by incineration	1·76	1·89	3·3	3·4	2·5
Of which, organic	0·48	0·56	1·28	1·12	0·56
Hardness (degree)	12·5	13·5	14·5	16·5	15.5
Ditto after boiling	4·0	4·0	4·0	8·5	5·0

Composition of sandy-looking material from upper part of slope of covered Reservoir, taken February 24th, 1867.

Carbonate of lime and magnesia, with aluminium and peroxide of iron	82·1
Land (siliceous)	4·4
Moisture	12·8
Organic matter, oxydized by permangan	0·7
	100·0
Loss by ignition after being dried at 300 Fah.	4·5

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part from the river. Mr. Greaves, however, suggests that the spirts on the north slope of the east reservoir may have arisen simply from the water which had found its way from the reservoir, when full, behind the brickwork. But Captain Tyler thinks that the reservoir had been too long emptied for this supposition to hold good, and he believes that the chemical analysis of the water collected from the spirts on the slope and at the site of the sluice, as well as from the bottom of the reservoir where issues were observed, confirms the conclusion that there is soakage from the Lea into the covered reservoirs at the points referred to. Although, however, the fact of soakage is to be held as demonstrated, the quantity (notwithstanding that the soakage would be of daily occurrence as the contents of the reservoirs were pumped out and the level of the water fell below that of the river) is so small, as compared with the body of water passing through the reservoirs, that its existence had not been indicated by chemical tests (or, if indicated, the indication was not understood. *See* note p. 285).

The liability of soakage into the uncovered reservoirs from the river Lea has a more intimate bearing upon the present investigation than that of soakage from the same source into the covered reservoirs. Shortly before the outbreak of cholera the southern uncovered reservoir was emptied by pumping the contents into Pudding Mill river. So great was the soakage after the operation that the reservoir filled from this source in a few weeks—how many or how few I have not been able to ascertain. The water thus forcing its way into the reservoir may have come from two sources, the northern uncovered reservoir and the rivers. Springs also in the bottom of the reservoir may have helped to the final result. Whether any of these sources of water-flow predominated cannot be stated, but the level attained in the end by the water was that of the ordinary level of the rivers, and of these the river Lea only concerns nearly the present subject. Of the soakage from this river, as from the other source of soakage, into the southern uncovered reservoir at the time mentioned no reasonable doubt can be entertained.

The level of the northern uncovered reservoir in June and July, 1866, is not known. It may have been, and probably was, somewhat above the ordinary level of the river Lea, as this reservoir received then more or less waste water from the filter-beds at Lea Bridge, and an occasional overflow from the covered reservoirs. But the level remained at all times below Trinity High Water mark. The river Lea opposite the reservoirs is, as already stated, a navigable locked canal, extending from Bromley locks to Old Ford locks. This portion of the river is of less than a mile and a half in length, and it has usually only such motion as is given by the influx and efflux of the tide when the later rises above the level of the ponded water. The river also at this part of its course, in June and July 1866, was a cesspool as well as a canal, for it then received the sewage of the large population inhabiting Old Ford, Bow and the greater portion of Bromley, and part of Mile End. Opposite the Old Ford reservoirs the depth of the river below its ordinary level is eight feet and the bottom is gravel, no doubt a part of the same stratum which underlies and forms the bottom of the uncovered reservoirs, the depth of the latter being greater than that of the river. During ordinary spring tides, the water rises in the river from two to three feet. On the 29th and 30th June, 1866, it rose 2 feet 9 inches, as shown by the tide register kept at the entrance of the Limehouse Cut. Notwithstanding the comparatively slight amount of tidal elevation of the Lea above the ordinary level of the uncovered reservoirs, it is highly probable, the very porous nature of the soil between the bed of the river and the bottom of the reservoirs being considered, that soakage from the former into the latter takes place. It is not a novel inference

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that the water in these reservoirs is affected by the tidal flow in the river. This has been suspected from time to time, although the question has not been subjected to direct examination.

Pollution of the river Lea with cholera evacuations, 26th and 27th June 1866.

Into the river Lea, cesspool and canal, at Bow Bridge, about 600 yards below the northern uncovered reservoir, were poured on the 26th and 27th June 1866, as shown in a previous section, the discharges of the first two patients who died of epidemic cholera in the East Districts. At the time the temperature was excessive, and it promoted in the highest degree putrefactive changes in the canal, which was in a peculiarly foul state from want of flushing. It is from this action of the temperature, and its probable effect in promoting choleraic decomposition in the excrementitious matter in the river, that I assign importance to the variations of atmospheric heat described in the meteorological section.

Moreover it is not to be forgotten that the sewage from the house in Archibald Street, in which a death from choleraic diarrhœa occurred on the 12th June, would pass into the Lea at a point about 200 feet distant from the northern uncovered reservoir.

From the consideration that if the Low Level Sewer of the Main Drainage System had been completed in June 1866, the discharges of the individuals first attacked with cholera would not have passed into the Lea, but would have been carried to Barking Reach, I attribute an indirect effect upon the production of the explosion of the disease in the East Districts to the fact that the new system of drainage was not completed as referred to in the section on sewerage.

Conclusion that the pollution of the water in common use, distributed from Old Ford, with cholera poison was the cause of the explosion of cholera in the East Districts.

In the foregoing section I have brought together the facts and inferences which appear to me to bear most directly upon the etiology of the explosion. I have shown that the river Lea was infected with the discharges of cholera patients on the 26th and 27th June, about 600 yards below the northern uncovered reservoir of the East London Water Company's works, and that this infection took place under conditions of temperature peculiarly favourable to the decomposition of the excrementitious contents of the river. I have shown that the northern reservoir in question is most probably liable to soakage from the Lea, and that water from this reservoir was distributed for domestic use to the localities supplied from Old Ford, late in June and early in July. It is difficult not to read the entire history of the explosion in the East Districts of the metropolis and their suburbs in the light of these facts, and conclude that the northern uncovered reservoir was drawn upon within the four or five days preceding the 11th July, and that the water of this reservoir had been infected with choleraic poison by percolation from the river Lea, or that a portion of the waters of the Lea so infected had been drawn directly into the service reservoirs through some flaw in the conduit leading between the covered and uncovered reservoirs.

This conclusion, if admitted, brings the whole of the facts of the explosion into ready accordance one with another, and supplies a sufficient and legitimate explanation of its origin. It is true, indeed, that the conclusion involves the assumption of the propagation of choleraic decomposition to a larger volume of water laden with excrementitious matter (the locked portion of the Lea from Old Ford to Bromley) than hitherto supposed, and the efficiency of the choleraic poison under a condition of enormous dilution, not previously surmised, and these assumptions must not be lost sight of in estimating the probability of the conclusion.* A direct soakage from the river Lea into the

* Chemical analysis of the water supplied by the East London Water Company has not helped to an explanation of the outbreak. Professor Frankland, F.R.S., made a special examination of the water for the Registrar-General (See *Return for the week ending 4th August*, p. 279) and with the result that the water supplied by the

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covered service reservoirs at Old Ford being admitted, it might seem at the first glance that the pollution of the water with choleraic poison and subsequent explosion of the epidemic in the East Districts would be most naturally traced to this source. The reasons for rejecting this explanation will be given in the next section, when certain exceptions to the theory that the cause of the explosion was the dissemination of choleraic poison in the drinking water will be considered.

4. Several objections have been advanced against the conclusion arrived at in the foregoing sections, some based upon the prevalence of cholera in localities of the district of explosion which derived their water supply from other sources than Old Ford, others upon the immunity of certain classes of the population and institutions, also of certain localities. These objections require to be considered.

Objections to the conclusion that the water in common use, polluted with cholera poison, was the cause of the explosion.

(*a.*) Of the first class of objections two principal instances are cited—one, the outbreak in Crown Court, Blue Anchor Yard, Whitechapel; the other, the outbreak in the City of London Union workhouse, Bow Common.

The outbreak in Crown Court, Whitechapel.

The outbreak in Crown Court, Blue Anchor Yard, supplied with water by the New River Company, has already been described (p. 277), and it has been shown that it did not form a part of the original explosion of cholera in the East Districts; and that the first death did not occur until after the disease had prevailed ten days in the immediate vicinity, and not until the propagation of the malady by other means than the water supply was in full force.*

The outbreak in the City of London Union Workhouse.

The history of the outbreak in the City of London Union workhouse is of great interest. This building, a palatial structure, is situated upon Bow Common, having the Mile End Road in front, the Tower Hamlets cemetery in the rear, and rows of houses of comparatively recent construction on each side. For the facts relating to the outbreak I am indebted to Mr. Chas. H. Buncombe, surgeon to the infirmary of the workhouse. The first case occurred on the 24th July 1866, the last on the 4th August. The disease was, with one exception, limited entirely to patients in the infirmary at the time, and to persons occupied about the infirmary. Altogether 42 persons were attacked, of whom 27 died; 26 were seized with the malady on the 24th and 25th of July, 10 during the three days

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Company on the 1st of August was "considerably better than that supplied on the 1st July." At the latter date the quantity of organic matter contained in the water was "markedly above the average." Professor Frankland adds, however, that although chemical analysis showed "a larger quantity of organic matter than ought to be contained in water used for drinking purposes," it did "not reveal any exceptional degree of pollution in this water." Professor Frankland does not state from what part of the Company's works the water subjected to analysis was taken. No analysis of the water distributed from the Old Ford reservoirs was made during the period when impure water obtained from the Northern uncovered reservoir was most probably circulating in the mains. I give in the *Appendix* Professor Frankland's analyses; also certain analyses of water supplied from the Old Ford reservoirs, and taken from the main at the London Hospital, with which Dr. Letheby has most kindly favoured me.

* "The infective influence of choleraic discharges," writes Mr. Simon, in continuation of the paragraph quoted on page 282, "attaches to whatever bedding, "clothing, towels, and like things, have been imbued with them, and renders those "things, if not disinfected, capable (as the cholera patient himself would be capable, "under the same conditions) of spreading the disease in places whither they are sent "for washing or other purposes; that, in the above described ways, even a single "case of disease, perhaps of the slightest degree, and perhaps quite unsuspected in its "neighbourhood, may, if local circumstances co-operate, exert a terribly infective "power on considerable masses of population. 'If local circumstances co-operate,' "however, is the stated condition for that possibility; and it will be observed that the "essence of the sanitary precautions, which have been recommended to nuisance

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following, and six in the course of the week ending the 4th of August. The majority of the persons attacked were very aged, and all, with two exceptions, were more or less indisposed. Not a single case of diarrhœa or cholera had occurred among the general population of the workhouse numbering 617 souls.

The infirmary is a large detached building (*see Plan of Workhouse*), accommodating 179 patients, and situated at the south-east angle of the premises. It consists of three floors, and the principal wards run east and west at the northern and southern extremities of the building, projecting on each face slightly beyond the central block. These wards are two in number on each floor, and at each extremity of the building, a smaller ward to the east and a larger ward to the west. There are wards also on each floor in the western portion of the central block. A corridor running north and south communicates with the different wards, and in the north-west and south-west angles of this corridor are the waterclosets, and sculleries immediately adjoining the doors of the smaller northern and southern wards. The doors of the larger adjacent wards are separated from the doors of the smaller wards by little more than the breadth of the partition wall dividing the wards. In fact each angle of the corridor facing the staircase is occupied by four doors, two communicating with wards, the others with a watercloset and a scullery, or, as on the second floor, with two waterclosets; and a watercloset door is on each floor 30 inches only from the nearest jamb of the most distant ward door. The ward doors look into the corridor, the waterclosets and sculleries face the staircase, which at each extremity of the corridor connects the different floors.

The structural arrangement of the building is defective, as the above details show, but the regulation of the wards with respect to the comfort of the patients reflects the highest credit on the management. They are bright, eminently clean, and enlivened by a little colour and ornament, which are very grateful to the eye. The beds as a rule, under ordinary hospital circumstances, would be too numerous in each ward, but their number is, I presume, determined by the nature of the cases and character of the patients chiefly occupying them, the old and infirm occupants of the workhouse not commonly suffering from acute disease.

The infirmary, as the rest of the workhouse, is supplied with water entirely from an Artesian well 250 feet deep. The water from this well was analysed at the time of the outbreak. It contained neither ammonia nor nitrates, and, beyond being somewhat hard, was faultless.

The drains of the building pass immediately outside it, but a drain, which at the time of the outbreak, carried off the fluid refuse of a large piggery and stable, placed near the south-west angle of the infirmary, runs beneath the south-east angle. The piggery has since been done away with.

The first case of cholera in the infirmary (then having 148 patients in its wards) occurred, as already stated, on the 24th of July, that is to say, when the direct effect of the exploding agent of the disease in the East Districts had, as has been shown, most probably ceased,

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" authorities and others, is to annihilate those 'local circumstances.' The choleraic " infection does not seem able largely to injure any population unless a filthy state of " things be pre-supposed. It is pre-supposed that the atmosphere or the drinking " water of the population is impure with the most loathsome of impurities; that the " infective material has had opportunities of action which decent cleanliness would not " have afforded it; that, in inefficient drains or cesspools or other like depositories, it " has had time to develop its own infective power, and to render other stagnating " filth equally infective with itself; and that, from such foci of infection, the dis- " gusting leaven of the disease has spread, in air or water, to be breathed or swallowed " by the population."—*Official Memorandum, July 24th,* 1866.

and after numerous deaths from cholera had taken place in the neighbourhood. With this neighbourhood, or some parts of it, the population of the infirmary maintained a tolerably close correspondence, the sick by means of the visits of friends; and one case of cholera was brought into the wards from without the precincts of the workhouse.

Whatever the cause of the outbreak, and although clearly disconnected with the water supply, it as clearly occurred under circumstances in which transmission of the disease was very possible, and subsequent to the true explosion of cholera in the vicinity. This outbreak, then, does not militate in any degree against the theory here accepted to account for that explosion. It is not the less interesting, however, to seek for an explanation of it, and of its peculiar localization in the congeries of buildings of which the infirmary forms a part.

The patient first seized was a woman 52 years of age, and she occupied a bed in the south-western ward on the third floor. She had been in the infirmary seven days, and had been admitted from Queenhithe as suffering from diarrhœa. Whilst in the hospital the bowels were perfectly composed up to the moment of the fatal seizure, and any disturbance affecting them must have ceased on admission. She was struck down suddenly with cholera in the course of the day, no indication of indisposition having been noted previously. Virtually she was collapsed from the outset, and death took place in 12 hours.

The second case was a man, aged 75 years, acting as stoker. The furnace room is in the basement of the building, it has no communication with the interior, and is entered by a flight of steps leading directly from the yard on the east front.

The third case was a man, aged 66 years, who had charge of the gate leading into the infirmary yard.

Fifteen persons were attacked on the 24th July, the two men just mentioned and 13 women, six of the latter being in the south-west ward on the upper floor. On the 25th nine women were attacked; and during the next 10 days 11 other women and five men, making a total of 39 of the sick in the infirmary seized with the malady, and two healthy individuals employed upon the infirmary premises.

Of the seizures in the hospital, with one exception on the women's side of the central block, all occurred in the north and south wards, but the severity of the outbreak, represented by 34 cases and 22 deaths, fell upon the south wards in the women's division of the infirmary.

During the night preceding the outbreak a most offensive odour had pervaded the yard in front of the hospital to the east, and, to a less degree, the hospital. This odour was thought at the time to have come from the Limehouse Cut, then in a most obnoxious state. There are sundry manufactories, moreover, on Bow Common, which are apt at times to fill the surrounding atmosphere with ill smells, and which must not be lost sight of in tracing a foul odour in that district to its source.

But from an examination of the infirmary, and the workhouse premises generally, as well as of the atmospheric state at the time of the outbreak, my impression is, that the offensive odour was not carried to the infirmary and its precincts from a source outside the workhouse enclosure.

The greater portion of Bow Common and all that part occupied by ill-smelling trades, and the Limehouse Cut, are situated to the south and south-east of the workhouse; and the nearest point of the cut is close upon 2,000 yards from the south-east corner of the infirmary, the Tower Hamlets cemetery, the Blackwall Extension Railway embankment, open ground, and no lack of streets and houses intervening.

Throughout the 23rd July, on the evening of which day the offensive odour was perceived, the wind had blown from the N.E. and N.N.E. in

the morning; from the N.N.W. and N. in the after part of the day. During the six previous days the prevailing winds had been from the N.E. There were brief intervals of calm on the third, fourth, and fifth days preceding, but at no time during this period had the wind gone round to the south or become southerly. On the 24th and 25th also the wind blew from the N. and N.W., and whatever offensive smells might have been thrown off by the Limehouse Cut and from Bow Common, from the 18th to the 25th of July inclusive, would be blown away from the workhouse infirmary. Again the temperature, with one slight exception, during this period was below the average, and the weather dry—conditions not the most favourable to an exceptional production of foul odours from the sources indicated.

But the atmospheric state was not inconsistent with the origin of the foul smell from another source, which source was suggested by the peculiar limitation of the outbreak to certain wards of the hospital, and the relationship of these to the waterclosets and sculleries. This relationship is such that if from any cause there should be an up-draught along the soil-pipes and scullery-drains, and sewer air be poured into the corridors, the wards affected would be most exposed to atmospheric pollution from this source. The only exits for sewer air at the upper extremity of the east main drain of the workhouse are three gratings in the yard in front of the east face, the waterclosets, and scullery-pipes, and an opening near the stable, common at the time of the outbreak to the stable and piggeries.

One of the two openings in the yard to the east of the infirmary is close to the entrance of the furnace room ; another is close to the door of the gate-keeper's cabin. It was in this yard that the ill smell was most perceived, and it was the two individuals, one being the stoker, the other the gate-keeper, who would be most exposed to any ill consequences of a sudden inundation of sewer air who were among the first struck down.

The odour was common to the yard in question and to the infirmary ; it was not noted (accidentally or not is not clear, but it is certain that it was not noted) in the open space or in the imbecile wards behind the infirmary, or elsewhere about the large premises. The odour was localised in the infirmary itself, and the yard to the east of it. It is difficult to conceive that so marked an odour immediately preceding an outbreak of disease so fatal would have been unperceived in other parts of the premises if it had existed there. In the neighbourhood of the piggeries it would be masked by the smell from the sties. These considerations tend to strengthen the probability that the smell was derived from the infirmary sewers, and they set aside the assumption of its being transmitted to the premises from without.

The atmospheric state at the moment favours this assumption. After several days of excessive heat, on the 18th the temperature fell below the average of the previous 50 years, and, with one slight exception, it remained below the average until the end of the month. From the 16th to the 19th of the month there was a slow declension of the barometer, during the two last days of which the temperature gradually fell below the average. The condition of the atmospheric pressure and temperature in this period were such as to favour an upward current from drains into buildings without determining any very decided up-draught. From the 19th to the 21st the barometer went up again, the temperature, except on the 21st, remaining below the average ; but on the 23rd the barometer suddenly fell with a low temperature, indicating atmospheric conditions eminently favourable to upward currents from sewers. On the 23rd the barometer again

began to rise, and on the 24th it attained a higher elevation than it had reached during the previous thirteen days.

The occurrence of the offensive odour contemporaneously with a sudden fluctuation of atmospheric pressure and a comparatively low temperature is consistent with the assumption that it arose from a sudden efflux of sewer air. The facts appear to me to indicate that the infirmary and contiguous yard were during the evening and night of the 23rd, inundated with sewer air; and assuming this to be the case, and that this inundation might have a direct effect upon the subsequent outbreak, it is not difficult to explain the more disastrous consequences on the female side of the hospital. The wards chiefly affected (female) are lighted from the south and west, the wards least affected (male) from the north and west. The wind being from the north and upon the northern face of the hospital, the windows being alone used with the fireplaces for ventilating, the general direction of the principal current of air passing through the building would be, on the male side, from the windows through the doorways into the corridor; on the female, from the corridors into the wards and out of the windows or up the chimneys. Sewer air poured out from the waterclosets and sculleries into the corridors would, under these circumstances, pass directly and almost undiluted into the south wards, only incidentally and accidentally into the north male wards; while the portion swept down the corridor would be subjected to large dilution before it penetrated any of the intermediate wards.

And it is not simply a question of sewer air, but of sewer air from a drain containing choleraic evacuations; for the main drain running along the Mile End Road, into which the drains from the hospital empty themselves, must at this time have been surcharged with choleraic matter.

The question still remains, how, if the foregoing explanation of the outbreak be admissible, the disease appeared in the infirmary alone, and in none other of the mass of buildings; for the upward rush of sewer air must have been common to the whole series of drains of the workhouse, and not to any particular portion of them. In appearance, moreover, the female imbecile ward was as much exposed to permeation by sewer air as the infirmary. This ward is a detached building, occupying a similar position at the south-west angle of the workhouse precincts as the infirmary at the south-east, the distance between the two buildings being about 140 feet. The waterclosets in this building are even worse placed with respect to the wards than in the hospital, and the chances of contamination of the air of the wards from them is greater. The drain of this building, moreover, forms the upper portion of the east main drain of the hospital, and there is no inlet to it beyond.

On an examination of the plan of drains of the entire workhouse a very considerable difference is found in the distribution of the different drains on both sides of the buildings. East and west, as previously stated, a common drain runs the entire length of the buildings; these again pass obliquely beneath the "front building," or Lodge, unite in a single channel, and by means of this communicate with the main drain of the neighbourhood running along the Mile End Road. From the front of the Lodge, and passing towards the rear, the east drain communicates with the Lodge, the east side of the principal block, by two branches, with a series of latrines in the open court of the stone-yard by a single branch, with the infirmary by two branches, as well as with the infirmary yard, and finally with the stable-yard by a single branch. On the west side the common drain communicates as on the east with the Lodge and the contiguous portion of the principal block of buildings by two

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branches; but beyond this point, and before reaching the female imbecile ward, it receives branches from four large series of latrines and urinals detached from the buildings, and standing in open courts. Now, assuming a sudden rush of air upwards in and along the common drains, and that this rush was manifested chiefly (as, on physical grounds, it may be presumed to have been) towards the upper portions of the drains, the diffusion of the sewer air, or rather the facilities of egress, would be infinitely greater on the west side of the buildings than on the east. On the latter side the chief facilities of egress are found within the infirmary, on the former in the series of latrines fixed in open courts; and it is reasonable to suppose that from this difference in the facility of diffusion of sewer air in an upward rush on the two sides of the building, the chief diffusion on the one side being determined in the open air, on the other in a crowded infirmary, the localization of the ill effects assigned to such a rush is to be attributed. Moreover, a flow of sewer air up the waterclosets of the principal block of and front buildings, from the arrangement of the former, would be little appreciable. The basement waterclosets are, in fact, outside the building, and a rush of sewer air from them would rarely penetrate it. The aeration of the other waterclosets is so large as largely to obviate danger from this source, and the probability of mischief being thus induced exists markedly only in the rearward closets on the first floor (*See Plan*). The mode of junction of the common drain of the workhouse with the main sewer is worthy of note. A current of air passing along the latter from west to east would affect almost solely the east drains of the workhouse.

In what manner sewer air becomes charged with cholera poison I do not know; but that it may become so charged I think will scarcely be questioned. And in this instance the common drain communicating with the infirmary terminates at a distance of a little more than 200 yards from the building in the main drain of the neighbourhood, which drain at the time of the outbreak must have been abundantly laden with the evacuations of persons suffering from cholera.

[Subsequently to the making of this report, and while it was in course of being printed, Mr. Radcliffe, at my request, made a special inquiry as to the soil on which the workhouse is built, and informed me as follows :—" A glance at the geological map will show that the " buildings are partly situated upon the edge of a field of brick-earth, " partly on gravel. The infirmary indeed is placed entirely beyond the " edge of the brick-earth and upon gravel. But I learn from the " architect, Mr. Richard Tress, that the foundations of the entire build- " ing, with the exception of the imbecile ward, are sunk into a clean, " small, yellow gravel with little sand. The imbecile ward was built " upon the site of an old and tolerably deep pond. Mr. Tress is unable " to speak precisely of the nature of the subsoil at this spot, but he " intimates that the bottom of the pond was clay, the superficial beds " having been cleared away. There is probably much 'made-earth' " beneath the building, formed in filling up the pond beneath the " imbecile ward."—J. S., May 31st.]

Immunity of certain sections of the population.

(*b*.) The immunity of certain sections of the population, living in the districts where cholera most prevailed, and drinking the water assumed to have been the cause of the peculiar prevalence, has been urged against that assumption. Mr. Orton, the Medical Officer of Health for Limehouse, maintains this objection. In his report to the Board of Works of his district on the epidemic he states that during its progress the people who especially drink water, particularly teetotallers, were " pre-eminently exempt " from its influence. He instances, in support of this statement, the City of London Temperance Society. Out of

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several hundred members, "a large body of whom live in the Tower "Hamlets, only three, one man and two women," Mr. Orton writes, "and these, under exceptional circumstances, have died from the com-"mencement of the epidemic." He instances also "The Sons of Phœnix," a total abstinence society, numbering 1,250 members, all living within the limits of the East London Water Company's supply, of whom two only died during the epidemic. "The United Phœnix," another total abstinence society, consisting of 1,400 members, living in the East Districts, lost only two males and three females. Nine-tenths of the members of both societies, I may state, from personal inquiry, probably reside within the area supplied with water from Old Ford. Mr. Orton further says that he "is acquainted with numbers "of families, some with filtration, others without, who have gone "on drinking water all the season without a single case of "diarrhœa." He writes, moreover, that "At a brass-founder's in "the Back Road a number of men are employed, an occupation "inducing great thirst, and I am credibly informed that each man "during the summer was in the habit of daily drinking a gallon of "water on the average, without a single case of diarrhœa occurring. At "14, Love Lane, Ratcliff, the mother, husband, and sister died, who "were not drinkers of water but practised moderation. The five children "escaped altogether from an attack of diarrhœa, while, to use her own "words, they were doing nothing else but 'drinking water all day long!' "Let me add, pretty generally amongst all classes the theory of the water "poison is repudiated, especially among the poor, who have chiefly felt "the shock; and this opinion is very commonly shared by professional "men." Mr. Orton also expresses the opinion that "19 out of 20 adults "who have perished were not water drinkers even occasionally, except "in the ordinary cooking of their food" (p. 4). He states, moreover, "that it is a fact beyond dispute" that out of 400 children in the Limehouse establishment for pauper children, "who had free access, and "were drinking water all day long, that there was not even one case "of common diarrhœa" (p. 11).* This establishment is situated in the lower part of the district, and in the midst of an infected locality. Finally, Mr. Orton refers to the comparative immunity of the paupers in the Stepney Union Workhouse at Bromley, and in the Poplar Workhouse (p. 14).

Dr. Corner, the acting medical officer of health for Mile End Old Town during the epidemic, also objects to the theory that the water supplied to the East Districts was the principal medium by which the cholera poison was propagated at the outset of the explosion. He founds his objections, first, on the want of simultaneity of the outbreak in all parts of the district supplied with the suspected water; and, secondly, upon an examination "into the circumstances of more than 100 fatal cholera cases." Of these cases he writes, that "in not more than 5 per cent. "had the patients drank of the water at all, and those only after it "had been boiled; and," he adds, "we have no sufficient practical or "reliable proof to show that this temperature does not destroy life."*

The foregoing are the sole objections of this category which have been communicated to me, or, so far as I am aware, have been advanced. The details which have been given of the early history of the explosion in the East Districts show that Dr. Corner's argument, derived from the assumed absence of its simultaneousness, cannot be sustained. The results of his personal investigation of 100 fatal cases in respect of the

* Special Report to the Health Committee of the Vestry of Mile End Old Town upon the Cholera Epidemic of 1866, p. 20.

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patients' use of water would bear upon the question at issue only if the cases had occurred between the 11th and 21st July, of which there is no evidence.

Mr. Orton's principal instances do not altogether sustain his objection. Taking the facts with respect to the two Phœnix total abstinence societies barely as he gives them, it is found that the mortality from cholera among the 2,650 members was at the rate of 26·4 per 10,000. The great difference in the mortality between the "Sons of Phœnix" and the "United Phœnix" is noteworthy, as indicating that total abstinence was not alone concerned in the apparently slight incidence of the epidemic upon the members. Again, data are altogether wanting to show how far habits most conducive to good health and domestic well-being may have heightened the power of resistance to the poison of cholera, and to what extent this may have shown its influence in slighter grades of indisposition. There is no history of the prevalence of diarrhœa among the members.* Mr. Orton's reference to the City of London Temperance Society is still more defective, the number of members not being given.

Customs officers.

Even if it were proved that total abstainers suffered in a less degree than the general population it would still have to be determined, before the conclusion sought to be attached to the fact could be legitimately deduced, to what extent this immunity might have been dependent upon a degree of physical and social well-being which, as measured by the mortality, presumably conferred a greater immunity upon other sections of the population inhabiting the same districts, but not total abstainers.

The sections I refer to are the Customs' force, and the letter-carriers and other officers of the General Post Office. Respecting the former, Dr. Walter Dickson, R.N., the medical inspector of the Board, has favoured me with a most interesting memorandum, which relates not only to the men themselves but in part to their families.

The Customs' force in London, in 1866, numbered 828 men, of whom 595 lived in the Tower Hamlets.† Many of the men lived in streets in which the epidemic prevailed most severely. Not a single case of malignant cholera occurred in the entire force, but there was not a like freedom from diarrhœa. Ten cases of severe diarrhœa, requiring vigilant and continuous care, took place among the men residing in the Tower Hamlets, and one ended fatally, the patient having long suffered from disease of the heart. Besides these cases there were several of a less severe character (43 in the entire force), and many instances of trifling disturbance of the bowels.

Among the families of the force the influence of the epidemic was almost equally little marked. Dr. Dickson is not aware of the death of more than one adult, and of one or two children from cholera, among probably upwards of 2,000 individuals, wives and children. But bowel complaint existed in some of the men's families at the time when the men themselves were suffering from the malady, although in the great majority of instances this coincidence did not occur.

Writing of the whole force and of its immunity from the severer forms of the epidemic, Dr. Dickson says :—

"The sanitary conditions of these officers and their families are good.

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* I have since learned from Mr. Thomas Wilson, the secretary of the United Phœnix (or rather United Sons of Phœnix Society), that the number of cases of sickness from cholera and diarrhœa among the male members, 860 in number, during the epidemic did not exceed 30.

† The residences of these men were distributed as follows :—146 in Wapping, Shadwell, and Saint George-in-the-East ; 260 in Mile End and Stepney ; 84 in Limehouse, Poplar, and Barking ; 105 in Bow, Bethnal Green, Hackney, and Old Ford.

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They are generally steady and sober men—hardly any are total abstainers, and many, from the nature of their duties, drink daily a considerable amount of wine or spirits. Nearly all drink beer or use tobacco. Their incomes range from 70*l.* to 80*l.* a year and are secure; their houses and persons are orderly and cleanly, and their social position is generally better than that of their neighbours who have often higher wages, but from whom they keep usually much apart. They are absent from home nearly all day on duty on or near the river and in the docks, and about one-fourth have night work occasionally. They are usually married, with families of from three to eight persons."

Each man, Dr. Dickson proceeds to say, is at all times furnished with a small quantity of an aromatic astringent powder,* to be used in case of diarrhœa, until medical aid is procured, either by himself, his family, or the passengers or crews of ships of which he may be in charge; and supplies of this powder are kept at the Custom House, and all the stations at the docks and on the river. Instructions are also given for the general sanitary guidance of the men, and during the epidemic a special recommendation was made with reference to boiling the drinking water; but the instructions are neglected, and the recommendation was not commonly followed.

Dr. Dickson adds :—" The immunity of [the men] and of their families, " amounting probably to 3,000 persons, is singular and inexplicable, ex- " cept on the supposition of a better general sanitary condition of the " individuals and their dwellings, and probably in some degree by the " ~~timely check of the disease by~~ medicine in the incipient stage. For it " is obvious that this body of men were by no means exempt from the " prevalent epidemic influence, as cases of bowel complaint of a slight " character not requiring withdrawal from duty were very common, and " the cases entered on the list were much more numerous than in ordi- " nary years."

Letter-carriers and other officers of the General Post Office.

Among the entire force of the General Post Office, numbering 1,921 men, Dr. Waller Lewis informs me that not one case of cholera occurred, and only one case of choleraic diarrhœa. In the latter instance the man lived in the Bethnal Green Road, and he was attacked immediately after the death of his wife and a child from cholera. But among the letter-carriers in the east district, and those engaged in the eastern portion of the east central district, diarrhœa was prevalent. Of 81 men employed in the first-named district 23 were incapacitated from duty for a longer or shorter period by diarrhœa; others suffered to a less extent. Dr. Waller Lewis put in force an admirable plan of preventive measures, and each man was required to carry about with him constantly a small quantity of confection of opium to use in case he was attacked with diarrhœa on his beat, and to keep in his house an aromatic astringent mixture with opium to use if he were seized whilst at home. To the adoption of these means Dr. Waller Lewis attributes largely the escape of the force from the severer and fatal forms of the epidemic.

This immunity of the men employed by the Customs and the General Post Office from cholera and from fatal diarrhœa was due to a combination of causes, the influence of each of which in producing the result it is difficult to estimate. Some of these causes it is to be presumed would be equally operative, some, perhaps more, among a section of the population distinguished like the total abstainers, by a larger amount of physical well-being than, as a rule, belongs to the mass of population to which they belong. It would be necessary to eliminate the effect of these causes in reducing the aptitude to choleraic infection,

* The powder is composed of chalk, opium, catechu or kino, and aromatics.

whether through the medium of water or any other medium, before concluding from such reduction that the individual had not been subjected to the liability of infection. The argument derived from this immunity against the theory that water is a medium of choleraic infection would tell also in a greater or less degree against other media of infection.

Immunity of teetotallers not proved.

But as the facts stand a peculiar immunity of total abstainers from the epidemic has not been proved. The question is one of considerable interest, and I regret that I have been foiled in obtaining more precise information on the subject. I have thought it well, however, to touch upon some of its bearings in order to show the nature of the evidence which is required before it can be proved that total abstainers escaped in a marked degree from the influence of the recent outbreak in the East Districts, and if proved, before it can be legitimately inferred from such immunity that water could not have been the medium conveying the choleraic infection which determined the explosion of the disease in those districts.* The argument here sustained against Mr. Orton fails, however, in respect of the pauper children in the Limehouse establishment. This is the most weighty of his objections, and I am not able to advance any explanation which would satisfactorily remove it.

Immunity of certain institutions.

The Limehouse school for pauper children.

The school, indeed, is closely hemmed in by streets in which cholera prevailed largely, and a constant communication was kept up of necessity with the infected neighbourhood. If, however, good feeding and an excellent sanitary state of surroundings may afford an escape from cholera, then the children ought to have escaped. It has never been my lot to visit a school more admirably managed, or kept in more excellent order and cleanliness. But it is not the less true that the establishment, in the daytime, is supplied entirely with water from the Old Ford reservoirs, that the children have free and unrestrained access to a stand-pipe which communicates directly with the East London Water Company's main, and that they draw from and use freely the water obtained from this stand pipe at all times.† No interruption occurred in the use of this stand pipe either prior to or during the explosion of cholera in the East Districts; and it is right to state that Mr. James Tilwell Hawkins, the medical officer of the establishment, assigns as one cause of the escape of the children the free and unrestrained use of the water, held by him to be then and usually very excellent. Not a single case of cholera or epidemic diarrhœa occurred

* I have been favoured with the following information respecting one Metropolitan Total Abstinence Society, through the courtesy of Mr. Thomas Jones, the chairman, Mr. E. Greene, the secretary, and the committee of the National Temperance Brotherhood, a friendly society. This society has about 300 members. I subjoin Mr. Greene's reply to some queries of mine. He writes :—" Having examined the register " of members, the sick claims, and medical certificates for 1866, I find that in the East " Districts of the metropolis, south of the Eastern Counties Railway, we had 64 mem- " bers in 1866, that no claim was made on account of cholera and but one on account " of diarrhœa, and that for two days duration only. . . . . . I may add that many " of our members reside in streets and places where cholera and diarrhœa were most " prevalent last summer and autumn." I sought to obtain a statement of the surgeon of the brotherhood of the state of diarrhœa among the members residing in the East Districts, but was unsuccessful. It is not unimportant to state in connexion with this subject, that the treasurer of the " Sons of Phœnix Society," Mr. Blackwell, and the treasurer (Mr. Penny), and secretary (Mr. Thomas Wilson) of the " United Sons of Phœnix Society " assert that it is altogether an error to suppose that total abstainers are water drinkers. They aver that the total abstainer is peculiarly abstinent in his use of water or any drink whatever. It is unusual for him, in a hot season even, to take more than a most moderate allowance of tea or coffee, rarely simple water, and on this account Mr. Blackwell thinks that the comparative immunity of total abstainers in the Old Ford water district affords no support to Mr. Orton's argument.

† The entire water supply of the establishment is taken direct from the main, no cisterns intervening.

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among the 400 children. A long-ailing strumous child died from diarrhœa apparently incidental to the constitutional complaint. Except a necessary intercourse with the neighbourhood every precaution was taken to protect the children from the epidemic. Children admitted to the school during the outbreak were subjected to a strict quarantine of not less than three days. Eight children were received suffering from diarrhœa. These were subjected to special rules of isolation and disinfection. One of these children died, the cause of death being certified as "choleraic diarrhœa." The waterclosets used by the children were also placed under surveillance, the sentinels having directions to report every child who visited them more than once in the 24 hours. Much of the safety of the school is no doubt to be assigned to these wise precautionary measures energetically carried out by the medical officer and the master, Mr. Moseley.

[Subsequently to the making of this report, and while it was in course of being printed, Mr. Radcliffe, at my request, and with the assistance of Mr. Wm. Whitaker, of the Geological Survey of England, made a special investigation of the soil upon which the school is built, and informed me as follows:—" The investigation brought to light the " hitherto unsuspected fact that the school and premises stand upon a " thick bed of fine brick-earth, and not upon gravel, as previously sup- " posed. A boring in the boys' playground, a little in the rear of the " main building, gave 5 feet of made soil and $11\frac{1}{2}$ feet of brick-earth, the " latter not being bottomed. The streets immediately surrounding the " school, so far as could be ascertained, stand upon made earth and " gravel."* The interest of this fact, in relation to Professor Pettenkofer's doctrine of the influence of soil in limiting epidemics of cholera, cannot be overlooked.—J. S., May 31st.]

The Stepney and Poplar Union Workhouses.

The Stepney Union Workhouse is situated at Bromley, near to the spot where cholera first broke out, and in the midst of a locality which suffered severely from the epidemic. The building is comparatively new, it is erected upon a fine bed of gravel, and, notwithstanding certain structural defects, it is well ordered. The water supply is continuous. Service cisterns are filled from the East London Water Company's main by self-regulating taps, and the capacity of the cisterns being below the daily requirements of the building, water flows into them mainly during the day, and, when so, from the Old Ford reservoirs. The inmates of the workhouse use water as their ordinary drink, and at the time of the explosion of cholera in the neighbouring districts they numbered 580. Six cases of cholera and one case of choleraic diarrhœa occurred among them from the 25th or 26th July to the 5th or 6th August. All the cases ended fatally, the first death taking place on the 28th July, the last on the 8th August. No other cases of an epidemic character occurred among the inmates, and instances of diarrhœa were not more common during the epidemic than in ordinary hot seasons. The outbreak was confined to the women's side of the workhouse, and with one exception all the cases occurred in one ward. The first person attacked with cholera was 70 years of age. She was seized a few hours after having visited a house in Shadwell in which the disease was present at the time. Four of her companions in the same ward, three being of advanced age, were attacked in quick succession with cholera, and one was seized with choleraic diarrhœa. The sixth case of cholera took place in the same part of the building, the woman attacked having been in communication with the previous cases.

* I have to thank the Limehouse Board of Guardians for the readiness with which they granted me permission to make this investigation of the soil, and Mr. Swepstone, the clerk to the guardians, and Mr. Dunch, the architect and surveyor to the Board of Works, for their great kindness in facilitating the investigation.

The Poplar Workhouse is situated in the High Street, Poplar. It is an old building, the main portion of which is erected on a bank of gravel, the wings and rear buildings upon the edge of the alluvial flat of the Isle of Dogs. The water supply is obtained partly from the East London Water Company, partly from a well on the premises. The cisterns as a rule are filled from the East London Company's main at night, and the water will consequently be derived mainly from Lea Bridge. Occasionally, however, communication is opened with the main for a short time during the day. The same cisterns are used for the storage of the Company's water and the water from the well on the premises. Six of the inmates, 475 in number, were attacked with cholera from the 22nd July to the 27th August, inclusive, and three died. The attacks were not limited to any particular part of the workhouse, three taking place in the rear buildings, one in the east wing, and the remainder in the main building.

In the Poplar registration district, which includes Bromley and Bow, the proportion of deaths from cholera during the epidemic to 10,000 population was 90·8. Reduced to the same ratio the proportion in the Stepney Union Workhouse, Bromley, was 120, in the Poplar Workhouse 63. It would thus appear that the inmates of the Stepney Union Workhouse suffered from the epidemic to a greater extent than the general population in the vicinity, and that the inmates of the Poplar Workhouse although less seriously affected were visited relatively with some degree of severity. In fact both workhouses suffered to a greater extent than Mr. Orton was aware of.* But in neither the one workhouse nor the other can the cases of cholera be assigned to the dissemination of the poison of the disease in the drinking water. In the Poplar Workhouse the earliest cases occurred on the 22nd, 23rd, and 24th July. The individuals then attacked had all been resident in the building some time. They were three in number, one aged $2\frac{1}{2}$ years, one 76 years, and one 14 years. It is not known in what manner they contracted the disease; but (the date of occurrence of the cases and the circumstances under which the workhouse is supplied with water being considered) it is less difficult to imagine that the poison was carried into the building by persons or things, or both, coming from localities where the disease then prevailed, than through the medium of the drinking water. The woman first attacked with cholera in the Stepney Union Workhouse no doubt contracted the disease in the infected house at Shadwell. Doubtless, also, she communicated the malady to the six other women who were seized in the building, or, if not to all, to some of them, who acted as poisoning agents to the remainder. There is not the least ground for suspecting that an infected water supply could have played any part in determining this outbreak. But the fact of the outbreak would appear to indicate that no individual indisposition to be affected by the cholera poison had saved the inmates from an earlier and wider outbreak. If this inference be true, it is difficult to understand how they escaped from the disease, if at any time during the three weeks preceding the outbreak the poison of cholera had been disseminated in the water used by them for drinking.

(*c*.) The entire immunity of certain localities from the epidemic during the period of explosion, and of some throughout the outbreak, although receiving water uninterruptedly from the Old Ford reservoirs, presents a formidable objection to the theory here adopted.

Immunity of certain localities.

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* Mr. Orton's misapprehension in respect to the Poplar Workhouse has arisen from the fact that when an inmate was seized with suspicious symptoms he was at once sent to the North Street Infirmary, in reality the infirmary of the workhouse. If death occurred there, the death was registered as happening in the North Street Infirmary. Hence the apparent freedom of the workhouse, in the mortuary returns, from deaths from cholera.

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Stamford Hill.

In the sub-registration district of Stamford Hill, supplied at the time with water wholly from Old Ford, and having a population of about 5,500, there occurred only two deaths from cholera and three from diarrhœa; and the first death from cholera did not take place until the 24th July. At Lower Forest, Wanstead, Walthamstow, and Buckhurst Hill, east and north of Stamford Hill across the Lea, no deaths directly traceable to the epidemic took place. Leyton (including Leytonstone) supplied with water from Old Ford in the same manner as the villages last mentioned, suffered to some, but only a slight, extent rather late in the outbreak. Finally, in North Woolwich, which obtains its water solely from the same source, not a death from cholera, and not a case of the disease, so far as I can ascertain, occurred.

Villages north of Stratford.

The villages north of Stratford to which the mains of the East London Water Company extend, receive a very partial supply of water from Old Ford. The mains have been carried to these villages, but the dwellings connected with them are chiefly villas and houses and cottages newly built, and as a rule, of the higher class. The water, indeed, in these localities is distributed, and sparingly distributed, chiefly to a population enjoying a large degree of wealth and comfort. The like class of population living in the districts which suffered most from the epidemic, and most exposed to infection, appear to have been affected to a very slight degree by it.

Elevation can only have played a small part in securing the immunity of Stamford Hill from the epidemic, for the gross mortality here, at an average elevation of 76 feet above Trinity high-water mark, was only half that which occurred in Islington at an average elevation of 105 feet. The conditions as to the comfort and wealth of the population correspond very closely with those found among the inhabitants of the villages on the opposite side of the Lea, north of Stratford, using water from the same source.

North Woolwich.

But none of the causes here suggested, assuming that they might be efficient to that end, would account for the immunity of North Woolwich. This suburb is of recent construction, it consists mainly of ordinary cottage dwellings, built below high-water mark, and it differs in no respect as to site, sanitary defects, and character of population from Canning Town and Halleville. The water supply obtained from the Old Ford reservoirs is distributed on the constant system. The newer groups of cottages, situated between North Woolwich and the Victoria Docks, known as Silvertown, and supplied in like manner with water from Old Ford, also escaped from the first effects of the explosion of the epidemic. The direct effects of the explosion, indeed, extended to the houses north of the Victoria Dock (*See Map I.*), but no further. Why, on the theory that the disease was propagated through the medium of the water, cholera should not have spread at the outset to Silvertown and during the whole period of its prevalence to North Woolwich, I am unable to explain except on the supposition that none of the polluted water was distributed to those places.

Not only as regards North Woolwich, but also as regards Stamford Hill and the villages north of Stratford, this supposition is consistent with known facts. *Water is pumped ordinarily from the Old Ford reservoirs into the mains from half-past* 5 *o'clock in the morning to* 11 *o'clock in the evening. During the rest of the* 24 *hours, as previously stated, the mains are filled from Lea Bridge. On the day early in July when water was drawn from the northern uncovered reservoir, the sluice shutting off the communication between the two was not opened until the afternoon had advanced to some extent. The immediate reason for taking into the covered reservoirs a supply from the uncovered reservoir was to prevent the pump of shallowest suction becoming dry. For several hours, indeed, before the uncovered reservoir was drawn*

upon filtered water had been pumped into the mains from Old Ford. What became of this water? No records being kept at the Old Ford works which would throw light upon the subject, the distribution of this water must be entirely a question of surmise. But it is a fact that on the day of July in question, part of the district receiving water from the Old Ford reservoirs was supplied with filtered water from the filter beds at Lea Bridge, part with water polluted to a greater or less extent by unfiltered water drawn from the northern uncovered reservoir; and I can only suggest a suspicion (no proof on the subject being possible) that the difference of cholera and no cholera within the Old Ford district correspond to these inner distinctions of supply.

When the water from the uncovered reservoir was admitted into the covered reservoirs, the water in the latter had been pumped to a low ebb. The covered reservoirs at this moment probably were half emptied, and did not contain more than 3,000,000 gallons of water. To this quantity the 300,000 gallons taken from the uncovered reservoir would be added, assuming that the outflow from the pumps and inflow from the filter beds would balance each other.

The immunity of Stamford Hill, of the localities north of Stratford supplied with water from Old Ford, and of North Woolwich, seem to me to oppose a fatal objection to a long-continued circulation of water charged with choleraic poison, such as would have arisen from the soakage into the covered reservoirs from the river Lea, had that soakage polluted the waters to a poisonous extent. It is impossible to conceive that any section of a population could have been consuming water containing a destructive organic poison over a period of several days without suffering from its effects, unless the poison were in a state of dilution which rendered it inert.

The immunity of the districts referred to interposes an almost equally insuperable objection to the theory that the gradual elimination of the choleraic poison from the reservoirs at Old Ford (assuming this to have been admitted by a single indraught of water from the northern uncovered reservoir) would exercise a perceptible influence upon the course of the epidemic. Physically this gradual diminution would take place, but physiologically the immunity of the districts which escaped would indicate that after the first day's distribution of the poison its dilution became too great to exercise a perceptible effect.

An irregularity of distribution of the polluted water in the mains, arising from the mechanical arrangement of the latter and a presumed precipitation of the poisonous material, will not explain the immunity of the districts which escaped. Stamford Hill and the districts north of Stratford were supplied by separate pumps, and the water was too directly pumped to them to admit of the supposition that its constitution and condition could be much affected by precipitation, at least over all portions of the districts. North Woolwich, it is true, is the most distant district of least elevation from the reservoirs, and it would be likely to benefit more or less from any purification which water distributed to it might undergo from the subsidence of any solid polluting material.

The theory which best includes the principal facts of the explosion in the East Districts is that of *one* day's distribution of the cholera poison, in the drinking water, largely diluted but still in an efficient state. It is not necessary for more than one day's distribution of the poisoned water to account for the ascertained phenomena; and this assumption best permits a reasonable explanation, so far I can at present see, of the immunity of certain districts from the explosion.

Where so much is imperfectly known, the positive facts can alone safely guide us, and these I hold justify the general conclusion adopted in this report, notwithstanding the objections set forth.

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IV. *Influence of the Explosion of Cholera in the East Districts upon the Progress of the Epidemic elsewhere in the Metropolis.*

There are many circumstances of considerable interest which show that the explosion of cholera in the East Districts must have exercised no inconsiderable influence upon the development of the disease elsewhere in the metropolis. As this is above all things a question of evidence, I quote the facts which I have collected with reference to it simply as told by the relators.

St. Pancras.

Dr. Thomas Hillier, the Medical Officer of Health for Saint Pancras, writes to me as follows :—

"Some of the earliest cases of cholera in Saint Pancras were distinctly traceable to communication with the East of London. The first cases of undoubted cholera that came to my knowledge died on the 23rd July. One was a solicitor, living in Mecklenburgh Square, who had no connexion with the East of London that I know of; the other was the widow of a general dealer, who died at Ossulton Street, Somers Town. She had visited a daughter at Stepney, who had cholera, and washed linen for her. She was taken ill within 48 hours of leaving her daughter. Two children in this house took the disease and died; their grandmother who waited on them, residing in Wilstead Street, and her son living with her, also died of cholera, one on the 11th and the other on the 12th August. On the 22nd and 23rd July two children died in Bagham Street, Camden Town, who had come ill from 35, Tollett Road, Mile End Road, where there were children who had cholera. They came to the house of their grandfather in Bagham Street. He took the disease and died on the 27th July. On the 24th July the wife of an engine fitter died at St. Stephen's Place, Camden Town. She was taken ill two days after the return home of her husband. He came home ill and lingered till the 31st July. His death was registered 'Asiatic cholera nine days, jaundice three days.' He had been working in the Isle of Dogs. On the 25th and 26th July a man and his son died quite at the upper part of Kentish Town, in a newly-built street, Purerfield Street. I could not trace these cases to any communication with the east. These patients worked at brickmaking, at Belsize Park. Several other cases occurred in this house subsequently. After these cases there was in St. Pancras scarcely any well-marked cholera, and not more diarrhœa than is usual at that season until the first week of September. From this time onwards for several weeks cases of cholera and choleraic diarrhœa were constantly arising, which could not be traced to communication with an infected district. Sometimes I could find that the disease had been carried by persons in attendance on the sick to another house; the persons who carried the disease always having it themselves."

Dr. W. Tripe, the Medical Officer of Health for the Hackney district, writes :—*

"An investigation of the early cases proves, I think, that the disease was in many instances brought into the district. The man, Shipman, who died at Duncan Street, was taken ill at his work at Ratcliff (where the disease was prevalent), and died 21st (July) in 20 hours; another of the early cases, a man residing in Margaret Street, who worked at Bow, was also taken ill at his work, and died after 18 hours' illness; a woman who lived in the same street with the deceased, and who nursed him and his child, was attacked with cholera seven days after his death; three days after she was taken ill another inmate of the same house was attacked. Many cases such as these occurred."

* Report (to the Board of Works) on the Cholera Epidemic of 1866 within the Hackney District, p. 10.

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Dr. Letheby, the Medical Officer of Health for the city of London, writes :—*

City of London.

"The first fatal case occurred at No. 27, London Wall, in the week ending the 14th of July. The person attacked was not a resident of the city, but had come from Poplar, where the disease had just begun to appear. She was attacked the day after her arrival in the city, and she died in 24 hours."

St. Giles.

Dr. Buchanan, the Medical Officer of Health for the St. Giles district, writes of the week ending the 11th August, that cholera had "appeared " in a few houses, and was directly traceable to communication with " some infected locality."†

Chelsea.

Dr. Barclay, the Medical Officer of Health for Chelsea, writes :—

"A lad was found ill in the streets, belonging to a very unhealthy court, " who had been at work in the East of London. He was taken to the " parish surgeon, who, knowing the neighbourhood, very judiciously sent " him at once to St. George's Hospital." In this instance the disease did not spread.

Fulham.

Mr. F. J. Burge, the Medical Officer of Health for the Fulham district, writes :—

"Two imported cases terminated fatally—one from Bow, the other from Wandsworth. Such strict hygienic measures were resorted to (which I had full power to adopt) that the disease was apparently stamped out wherever it appeared in the Fulham district."

Wandsworth.

Dr. Connor, one of the Medical Officers of Health for the Wandsworth district, writes :—

"A man who lived at Fala's Place, Battersea, and worked at oil mills on Bow Common, was seized with cholera, and died in three days. His daughter died of cholera in 11 hours ; she was taken ill 48 hours after the father; had very little purging and vomiting ; the stage of collapse set in almost immediately. Both died on 23rd July 1866."

St. George, Southwark.

Dr. Bateson, the Medical Officer of Health for the St. George district, Southwark, writes :—

"A father, mother, and two children (the latter aged respectively six months and two years) came on a visit on the 29th July from Stratford to Wellington Street, Blackfriars Road, intending to return on the 31st July. Between these two days the children were seized with cholera and carried off. These were the only cases which happened in Wellington Street. In November two cases occurred in Wellington Place, a street running out of Wellington Street, connecting it with Friar Street."

St. Olave, Southwark.

Dr. J. Northcote Vinen, the Medical Officer of Health for St. Olave, Southwark, states that: "Fifteen cases of cholera occurred within the " district, of which three recovered and 12 died. The second case " which occurred was that of a German tailor, who with his family " came, towards the end of July, from Bethnal Green, to live within " the district. One of his children suffered from severe choleraic " affection immediately after the arrival of the family, and recovered. " A day or two afterwards the father was attacked by cholera ; he was " removed to Guy's Hospital, and recovered. His wife and the rest of " the family then removed from the house in which they had been " living to a large house in Tooley Street. Here the wife was attacked " by cholera, was taken to Guy's Hospital, and died there on the 1st of " August, after an illness of three days. An old woman, a servant in

* Report on the Sanitary Condition of the City of London for the quarter ending September 1866, p. 11.

† Report to the Board of Works on the Sanitary Proceedings under the Orders of the Privy Council of the 21st July 1866, &c., p. 4.

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" the same house, was then attacked, taken to Guy's Hospital, and died " there August 11th. No other case occurred in this house. A child " who came to live within the district from Bethnal Green was attacked " by choleraic diarrhœa soon after her arrival. She recovered, and " one other case occurred in the same house. The man and the two " children appear to have contracted the seeds of choleraic disease in " the eastern districts before coming into this neighbourhood. The " disease in the two women would appear to be clearly due to transmis- " sion. All the other cases appeared to be, more or less, of a sporadic " character. No communication with any infected person or district " could be traced, excepting that perhaps of a charwoman, who " was attacked after having been engaged cleaning floors, &c, in " Guy's Hospital. Three children of the same parents, living together " in one room, were attacked by cholera almost simultaneously. They " were nearly half starved, and all died after a few hours illness. " There was no evidence in these cases of exposure to any source " of infection having taken place."

Lewisham. Dr. F. E. Wilkinson, the Medical Officer of Health for Lewisham, writes: " There were very few cases of cholera, but the history of " some of them is interesting from the apparent connexion between " this district and the infected districts. The wife of a man named " Thomas Reece had been to visit a relative at Poplar suffering from " cholera, and whilst there she had a sharp attack of diarrhœa. Two " days after her return home, to a house notoriously filthy, an infant " was attacked with true choleraic diarrhœa, and died in a few hours. " The day after the child's death Thomas Reece (a man of intemperate " habits) was attacked with cholera and died, but with the addition of " hæmatemesis eight hours before death. A woman who had been " visiting her sister at Plumstead (who died of cholera) was attacked " the day after her return home with choleraic diarrhœa, from which " she recovered. She had taken the precaution of having some of " her clothes destroyed at Plumstead to prevent being the carrier of " infection."

Putney. Dr. Whiteman, the Medical Officer of Health for Putney, writes:— " All the required cases of severity, which happily did not amount to " more than a dozen, were visited by me, and the influences at all likely " to have been exercised by communication with the then affected " districts (particularly those of the East) most carefully inquired into. " In no one instance, however, was the transmission of the disease " traced to the importation of any afflicted persons into the district, " nor could it be established that there had been any personal or other " communication on the part of those ill of the disease with the East. " Only one case of true malignant cholera proved fatal in the sub- " district during the prevalence of the epidemic, the sufferer being the " widow of a fisherman, aged 75, and at the time of the attack in very " indigent circumstances. This case was characterized by all the " symptoms of cholera in its most aggravated form, and terminated " fatally in about 20 hours after the seizure. There is every reason to " believe the disease in this case was transmitted (probably through " the secretions) from a grown-up son to the mother, the former " having, it appears by the return of the union medical officer, " Mr. Pritchard, suffered some time before from choleraic diarrhœa of " great severity, and had lain the whole of the time, nursed by the " mother, in the one small living and sleeping room used in common by " these two people. A separation was instantly effected on the mother " being seized, and the man happily made a good recovery. The " drinking water from a well into which percolation of the contents " of a neighbouring cesspool was considered more than probable, was

"deficient at the time, from the pump being out of repair, and a preference had been given to the water for culinary uses dipped from out "of the Thames which ran a short distance from the house. This "water, it was ascertained, had been drank by both mother and son for "some time previous to their illness. A few other cases of severity "at the water side were more than suspected to have had their origin "in the use of unfiltered river water under similar circumstances."

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The following information is taken from communications of the Medical Officers of Health to the Registrar-General* :—

Paddington. Dr. J. Burdon Sanderson, the Medical Officer of Health for Paddington, states generally that no fatal case had occurred in the parish, up to the end of August, which had not been imported.

St. George. Dr. Aldis, the Medical Officer of Health for the Belgrave district, St. George, Hanover Square, states that, "The first patient died of cholera "at 74, Cumberland Street. He appears to have been infected with the "disease at Stratford, whence he had come, suffering from diarrhœa, the "day before his death. He was much alarmed, as several persons whom "he knew had died of the complaint at Stratford." Another patient, a youth, admitted into St. George's Hospital, "had left his mother's "residence, in Manor Gardens, Manor Street, Chelsea, but was taken "ill at Bow a day or two after, when he was taken to the hospital."

Westminster. Dr. Lankester, the Medical Officer of Health for St. James, Westminster, states (Sept. 6): "We have had seven decided cases of cholera; "of these four had been in communication with cholera districts in the "east, the other three cases were not traced to any particular locality. "One case was very remarkable; a boy came from Poplar to stay with "his uncle at 5, Little Pulteney Street, on the 7th of August; he died "on the 9th, and his uncle went to his funeral on the 11th, and came "back, and died on the 13th."

Islington. Dr. Ballard, the Medical Officer of Health for Islington, states: "Our "first case was derived from the east end of London. The next occurrence was four days later, and then within two days 10 cases (nine "fatal) occurred in two parts of the parish more than half a mile distant "from the initial case."

Strand. Dr. Conway Evans, the Medical Officer of Health for the Strand district, states generally: "In nearly every instance of a so-called outbreak of "cholera in this district, I have succeeded, upon close investigation, in "tracing the importation of the disease, either directly or indirectly, "from infected localities."

Holborn. Dr. Septimus Gibbon, the Medical Officer of Health for the Holborn district, states that: "Very many of the cases of cholera in this district "have occurred to persons who had within a week previously visited "the localities in the East of London where cholera was prevalent."

Clerkenwell. Dr. Griffith, the Medical Officer of Health for Clerkenwell, writes: "The cases have been but few. The first sufferer of four in one family "apparently brought the disease from Whitechapel; this one recovered, "as did two others; the mother, however, died of cholera."

St. Luke. Dr. Pavy, the Medical Officer of Health for St. Luke, Middlesex, states "that: No epidemic outbreak of cholera can be considered to have oc- "curred in St. Luke's, there having been only a few (under 12) sporadic "cases, occurring at distant parts. In some of these cases there is direct "evidence to lead to the inference that the disease was contracted in a "cholera locality and brought into the parish; for example, a policeman, "who died in Mitchell Street, had been engaged on duty in Shoreditch; "a man in Turk's Head Court had been working at the docks; this "death was assigned to drinking impure dock water; a man in White "Horse Court had been working at the water side at Billingsgate; and

* Return for the week ending September 15, pp. 550–74.

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Shoreditch.

" a woman in Garden Court had just removed from Shoreditch, and " was ill when she came into the parish."

Dr. Barnes, the Medical Officer of Health for Shoreditch, writes, " I " attribute most of our cases to direct importation from the infected " bordering districts. A resident in Shoreditch has been in contact " with cholera patients in Bethnal Green, Whitechapel, &c., and has " come back to be speedily attacked. Then, this fact is common, a " second, rarely a third, case follows in the same house as the first; " there has been nothing in the nature of spreading beyond this. Dotted " or isolated cases have appeared in various and distant parts of the " district, but these have not become foci of radiation.

Lambeth.

Dr. Puckle, the Medical Officer of Health for Lambeth, states generally, that of the few cases of cholera in Lambeth, " a considerable " proportion were imported into the parish from infected districts, " or arose after great irregularity of living, or occurred in young " children."

Camberwell.

Dr. Bristowe, the Medical Officer of Health for Camberwell, states that in his district, " Some of the cases (one or two) were distinctly imported."

Greenwich.

Mr. H. N. Pink, the Medical Officer of Health for Greenwich, states that " Many cases of cholera have broken out in this district amongst " persons who have been working or staying in the Eastern Districts of " the metropolis, or who have been working on board ships in the " river."

Charlton and Kidbrooke.

Dr. Finch, the Medical Officer of Health for Charlton and Kidbrooke, writes, " Up to this date (5th Sept.) only two cases of cholera " have occurred in my district; the first, on 22nd of August, an im- " ported case from Blackwall, and the second on the 30th of August."

V.—RECAPITULATION.

A recapitulation of the principal facts and deductions, sought to be set forth in the foregoing chapters, will properly close this report, which it is to be understood deals only with the more prominent questions arising out of the outbreak.

(*a*) The outbreak in the metropolis was one of a succession of phenomena which indicated a wide-spread diffusion of cholera infection in the kingdom during the month of June 1866, and this diffusion was inseparably connected with a direct dissemination of the infection from the continent.

(*b*) Although facts are not forthcoming which would establish the direct dependence, by transmission, of the recent outbreak upon the outbreaks previously occurring in western Europe, the conclusion does not follow legitimately that no such dependence existed.

(*c*) The excessive diarrhœa accompanying the recent outbreak, as well as the two previous outbreaks in the metropolis, sprang up contemporaneously with the first cases of cholera, and is to be considered as a phenomenon entirely apart from the extraordinary development of diarrhœa which has occurred within the last twenty-five years.

(*d*) The earliest unquestionable cases of the outbreak took place on the 26th June 1866, on the East verge of the metropolis, upon the banks of the River Lea, and the outbreak reached its acme in the fifth week following.

(*e*) The mortality among the population was proportionately less from this outbreak than from any previous outbreak in the metropolis, but the disease was not less fatal in proportion to the number of persons attacked.

f. In London, by Mr. Radcliffe.

(*f*) Of the total mortality of 5,915 no less than 4,276 occurred in the East Districts of the metropolis and adjacent suburban districts of West Ham and Stratford. It was in these districts that the disease underwent the rapid and unexampled development which gave to the outbreak such formidable proportions in the fifth and sixth weeks of its duration.

(*g*) The unusual development of the epidemic in the East Districts, as compared with the rest of London, began in the week ending the 14th July; in the week following the rate of increase, as compared with the previous week, was nearly *seven* times greater than in the rest of the metropolis; but in the subsequent week the rate of augmentation became virtually the same over the whole of London.

(*h*) Neither the meteorology of the period, nor altitude, nor the nature of the soil, nor density of population, nor filth, nor the state of the sewerage, nor locality, affords any explanation of the peculiar localization of the outbreak in the East Districts.

(*i*) There is but one condition known which might become capable of propagating cholera common to the whole area of the outbreak, namely, the water supply.

(*j*) The sudden and virtually contemporaneous development of the outbrĕak over the entire area of prevalence indicated a medium of propagation common to, and capable of rapid diffusion over the whole area; its sudden declension indicated the temporary efficiency to this end of such a medium. The area of prevalence approximated with remarkable closeness to a particular field of water supply, and there are facts which seem to prove that this approximation was not accidental. It is known that, immediately prior to the outbreak in the East Districts of the Metropolis and neighbouring districts across the Lea, impure water was distributed over this field of supply, and it is highly probable that this water was charged with choleraic poison. It is submitted that these facts and inferences supply a sufficient and legitimate explanation of the great and explosive development of cholera in the East of London and its suburbs during the recent outbreak; and it is argued in respect of a serious objection to this theory, arising out of the actual or relative immunity from cholera of certain districts and institutions supplied with the suspected cholera-infected water, that in the present state of our knowledge of the outbreak, the positive and more generally applicable facts may justly, and for practical purposes, warrant a conclusion apparently in contradiction with certain negative facts of much more restricted application.

In concluding this report I would express my warm acknowledgments of the courteous assistance afforded me in making this inquiry by the Registrar-General, and Dr. Farr, F.R.S., and several of the gentlemen attached to the Registrar's-General Department; to many of the Metropolitan Medical Officers of Health, and others of my professional brethren; to the numerous clerks to Boards of Guardians, and other parochial officials, to whom I have had to apply for information. Particularly my thanks are due for the important aid given to me by Mr. Charles Greaves, C.E., the engineer of the East London Water Company; to Mr. W. Whitaker, B.A., F.G.S., of the Geological Survey of England; Mr. Bazalgette, the Engineer to the Metropolitan Board of Works, Captain Tyler, R.E., and the Rev. H. Whitehead, M.A.

APPENDIX.

TABLE I.—Showing the MORTALITY from DIARRHŒA in the different Weeks of 1865 and 1866.

	Weeks ending	1865.	1866.	Average deaths 10 corresponding Weeks 1856–65.	Mean temp. of Weeks 1866.	Average temp. 10 corresponding Weeks 1856–65.	DISTRICTS.				
							Weeks	North.	Central.	East.	South.
1st	January 7– 6	16	10	11·3	43·2	36·6	2	2	1	3	2
2d	„ 14–13	13	12	13·8	36·9	37·9	3	3	1	0	5
3d	„ 21–20	16	11	13·4	46·9	37·9	1	2	2	2	4
4th	„ 28–27	7	12	12·9	43·1	38·8	4	2	2	1	3
5th	February 4– 3	16	19	13·6	45·1	38·9	2	3	4	4	6
6th	„ 11–10	14	15	14·0	45·8	40·0	4	2	0	3	6
7th	„ 18–17	13	24	12·3	38·9	38·4	1	5	3	3	12
8th	„ 25–24	14	18	13·6	36·2	39·0	3	4	1	3	7
9th	March 4– 3	10	24	13·0	34·4	41·4	8	6	2	2	6
10th	„ 11–10	9	15	12·6	36·8	40·3	4	2	2	4	3
11th	„ 18–17	12	10	12·3	39·3	42·2	2	2	2	1	3
12th	„ 25–24	7	17	11·0	40·2	41·4	1	3	2	5	6
13th	Mar.& April 1–31	16	18	10·5	49·8	43·9	3	6	0	3	6
14th	„ 8– 7	10	9	12·6	42·4	47·0	3	2	0	2	2
15th	„ 15–14	18	16	12·6	47·8	45·9	2	5	1	6	2
16th	„ 22–21	26	16	13·7	50·8	47·8	1	5	1	4	5
17th	„ 29–28	18	16	13·1	52·6	47·7	1	1	2	4	8
18th	May 6– 5	14	16	12·8	42·5	48·5	3	1	2	3	7
19th	„ 13–12	22	15	14·7	51·7	51·1	1	4	1	5	4
20th	„ 20–19	25	14	13·4	48·1	54·4	3	1	4	4	2
21st	„ 27–26	27	16	15·5	52·0	55·4	2	2	2	4	6
22d	June 3– 2	38	19	18·5	56·2	57·3	2	5	5	4	3
23d	„ 10–11	44	22	18·9	61·0	58·2	7	6	1	5	3
24th	„ 17–16	93	20	29·1	58·5	58·7	5	1	4	6	4
25th	„ 24–23	187	43	48·8	58·1	60·1	10	6	6	14	7
26th	June&July 1–30	184	67	58·7	66·3	59·9	11	20	5	14	7
27th	„ 8– 7	301	102	95·1	56·3	59·9	16	23	18	26	19
28th	„ 15–14	267	150	119·0	68·2	62·7	18	37	28	37	30
29th	„ 22–21	280	221	164·1	62·2	63·1	37	54	31	60	39
30th	„ 29–28	261	349	201·1	59·3	62·0	48	78	44	123	56
31st	August 5– 4	207	354	185·6	58·8	62·0	46	79	42	125	62
32d	„ 12–11	201	264	184·1	57·7	63·8	31	51	31	101	50
33d	„ 19–18	116	194	178·5	58·0	62·6	28	40	22	63	41
34th	„ 26–25	115	129	161·9	61·2	60·0	15	21	13	41	39
35th	September 2– 1	89	128	146·4	60·2	59·9	6	15	9	122	46
36th	„ 9– 8	89	132	112·0	58·5	59·7	18	19	14	44	37
37th	„ 16–15	85	110	88·2	56·7	58·3	14	11	15	35	35
38th	„ 23–22	83	98	75·8	53·7	56·9	11	19	17	24	27
39th	„ 30–29	92	67	62·7	55·5	55·2	9	11	17	18	12
40th	October 7– 6	83	69	50·3	57·9	54·8	8	8	18	17	18
41st	„ 14–13	54	47	41·0	52·4	53·7	8	3	5	17	14
42d	„ 21–20	62	55	38·6	49·6	51·6	6	13	8	11	17
43d	„ 28–27	48	32	29·5	49·1	49·3	3	8	4	7	10
44th	November 4– 3	61	28	27·3	49·2	46·1	4	5	5	7	7
45th	„ 11–10	37	33	20·2	48·4	42·5	7	5	3	7	11
46th	„ 18–17	32	22	20·2	45·6	40·6	3	9	2	3	5
47th	„ 25–24	28	26	18·2	39·2	41·9	6	5	3	2	10
48th	December 2– 1	24.	15	17·9	38·7	42·7	7	5	1	0	2
49th	„ 9– 8	17	10	17·1	64·9	42·3	0	4	2	3	1
50th	„ 16–15	27	25	13·5	43·4	42·0	3	5	6	3	8
51st	„ 23–22	17	16	12·8	41·3	40·0	5	3	2	1	5
52d	„ 30–29	12	14	12·4	44·0	38·6	6	1	0	0	7

Appendix.

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f. In London, by Mr. Radcliffe.

TABLE II.—Showing the ANNUAL NUMBER of DEATHS from DIARRHŒA in the Metropolis from the Year 1838 to the Year 1866 inclusive.

Year.	Cholera.	Diarrhœa.	Total, 5 years.	Average Population.	Annual Average Deaths from Diarrhœa per 10,000 Population.
1838	15	393	—	—	—
1839	36	376	—	—	—
1840	60	452	—	—	—
1841	28	465			
1842	118	704			
1843	85	834	3,549	2,034,054	3·4
1844	65	705			
1845	43	841			
1846	228	2,152			
1847	117	1,976			
1848	*652	1,913	11,388	2,244,036	10·1
1849	* 14,125	3,463			
1850	127	1,884			
1851	213	2,271			
1852	162	2,164			
1853	*881	2,310	12,041	2,260,554	10·6
1854	10,708	3,235			
1855	146	2,061			
1856	145	2,251			
1857	215	3,145			
1858	130	2,093	12,207	2,681,463	9·1
1859	198	3,335			
1860	46	1,383			
1861	168	2,625			
1862	107	1,735			
1863	154	2,448	13,226	2,904,334	9·1
1864	154	2,861			
1865	193	3,557			
1866	*5,278	3,204	—	—	—

* Years of epidemic cholera.

TABLE III.—Showing the NUMBER of CASES of DIARRHŒA entered in the Poor Law Medical Officers' Books in several of the East Districts of the Metropolis from the Week ending the 7th April to the Week ending the 28th July 1866 inclusive.

Week ending	Stepney.		Bethnal Green, three districts only.		Mile End Old Town.			Whitechapel.		St. George in East.	
	Di.	Ch.	Di.	Ch.	Date.	Di	Ch.	Di.	Ch.	Di.	Ch.
April 7	1	—	—	—	$\frac{7}{9}$	2	—	9	—	1	—
„ 14	1	—	—	—	$\frac{14}{16}$	1	—	7	—	0	—
„ 21	0	—	—	—	$\frac{21}{23}$	2	—	6	—	2	—
„ 28	3	—	—	—	$\frac{28}{30}$	4	—	11	—	2	—
May 5	0	—	—	—	$\frac{5}{7}$	2	—	9	—	1	—
„ 12	0	—	—	—	$\frac{12}{14}$	7	—	12	—	4	—
„ 19	0	—	—	—	$\frac{19}{21}$	5	—	11	—	1	—
„ 26	1	—	—	—	$\frac{26}{28}$	1	—	14	—	1	—
June 2	0	commencing June			$\frac{2}{4}$	9	—	19	—	3	—
„ 9	0	—	—	—	$\frac{9}{11}$	4	—	10	—	1	—
„ 16	3	—	—	—	$\frac{16}{18}$	6	—	29	—	3	—
„ 23	4	—	—	—	$\frac{23}{25}$	8	—	21	—	7	—
„ 30	11	—	2	—	$\frac{30}{2}$	7	—	38	—	13	—
July 7	9	—	10	2	$\frac{7}{9}$	13	—	47	—	16	—
„ 14	27	4	5	—	$\frac{14}{16}$	18	—	74	—	21	—
„ 21	84	29	35	3	$\frac{21}{23}$	40	4	115	15	61	23
„ 28	78	42	76	11	$\frac{28}{30}$	84	12	204	19	140	41

TABLE IV.—Showing the MORTALITY from DIARRHŒA in the East Districts of the Metropolis during June and July 1866.

Week ending	Shore-ditch.		Bethnal Green.		White-chapel.		St. George in East.		Stepney.		Mile End Old Town.		Poplar.		Total, East Districts.	
	1865.	1866.	1865.	1866.	1865.	1866.	1865.	1866.	1865.	1866.	1865.	1866.	1865.	1866.	1865.	1866.
June $\frac{2}{3}$	1	0	1	1	4	2	2	1	2	0	0	0	0	0	10	4
„ $\frac{9}{10}$	0	0	3	2	0	0	2	1	0	0	1	0	1	2	7	5
„ $\frac{16}{17}$	3	1	6	1	4	2	0	2	1	0	2	1	1	0	18	6
„ $\frac{23}{24}$	6	5	3	2	5	0	3	3	4	1	2	3	5	0	28	14
„ $\frac{30}{1}$	10	4	6	4	12	1	9	0	2	1	8	2	8	2	55	14
July $\frac{7}{8}$	14	2	7	6	12	5	6	3	3	2	4	3	11	5	57	26
„ $\frac{14}{15}$	9	10	10	6	8	6	5	1	5	4	8	7	8	3	53	37
„ $\frac{21}{22}$	12	7	10	9	6	12	1	10	3	8	11	4	7	10	50	60
„ $\frac{28}{29}$	16	10	13	23	7	22	7	6	8	25	6	14	6	23	63	123

TABLE V.—Showing the MORTALITY from DIARRHŒA in the different weeks of 1848, 1849, 1853, and 1854.

Week.	1848.	Average of 5 years.	1849.	Average of 5 years.	1853.	Average of 10 years.	1854.	Average of 10 years.
1st - -	17	9	15	12	18	15	22	12
2nd - -	27	9	26	12	13	14	27	16
3rd - -	21	9	24	12	12	13	27	15
4th - -	22	9	17	12	21	13	30	14
5th - -	19	9	28	12	13	15	31	15
6th - -	23	9	32	12	13	15	20	15
7th - -	17	9	27	12	15	13	24	15
8th - -	20	9	23	12	24	13	28	14
9th - -	15	9	20	12	22	11	20	15
10th - -	14	9	18	12	13	10	19	13
11th - -	19	9	20	12	17	12	22	11
12th - -	15	9	15	12	22	13	22	13
13th - -	15	9	19	12	23	8	16	14
14th - -	10	9	8	12	20	10	22	10
15th - -	20	9	14	12	16	11	18	11
16th - -	13	9	18	12	18	10	26	13
17th - -	9	9	16	12	20	10	19	11
18th - -	19	9	20	12	16	10	25	11
19th - -	10	9	11	12	18	10	10	11
20th - -	14	9	15	12	28	11	17	11
21st - -	14	9	19	12	32	12	31	14
22nd - -	15	9	16	12	21	11	22	15
23rd - -	17	9	20	12	23	14	31	13
24th - -	21	9	36	12	24	17	31	16
25th - -	35	9	17	12	33	22	38	19
26th - -	42	9	30	12	28	29	25	25
27th - -	57	66	46	76	34	44	32	32
28th - -	64	66	89	76	54	63	46	47
29th - -	94	66	131	76	73	99	58	67
30th - -	173	66	224	76	81	112	84	105
31st - -	141	66	179	76	110	121	142	119
32nd - -	110	66	173	76	139	119	195	130
33rd - -	81	66	188	76	126	115	192	129
34th - -	63	66	240	76	137	109	214	124
35th - -	79	66	234	76	152	102	243	117
36th - -	61	66	272	76	131	90	276	112
37th - -	42	66	280	76	78	83	232	96
38th - -	46	66	238	76	89	70	190	85
39th - -	44	66	163	76	69	55	165	72
40th - -	47	21	135	23	71	45	98	56
41st - -	37	21	91	23	51	33	102	48
42nd - -	23	21	51	23	45	29	78	34
43rd - -	38	21	42	23	41	23	46	31
44th - -	38	21	31	23	38	19	33	25
45th - -	26	21	25	23	45	19	35	22
46th - -	26	21	21	23	36	16	13	22
47th - -	27	21	16	23	30	17	21	19
48th - -	24	21	17	23	31	16	19	19
49th - -	20	21	17	23	34	15	19	19
50th - -	24	21	14	23	27	14	25	18
51st - -	15	21	13	23	18	14	20	17
52nd - -	30	21	9	23	29	15	16	16

Appendix.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Table VI.—Showing the Weekly Mortality from Cholera in the Metropolis, during the four epidemics of 1832–33, 1848–49, 1853–54, and 1866.

Weeks.	First Epidemic.*		Second Epidemic.†		Third Epidemic.‡		Fourth Epidemic.§ London.	Fourth Epidemic.§ West Ham, Stratford, and Leyton.‖
	1832.	1833.	1848.	1849.	1853.	1854.	1866.	1866.
1st week	—	—	—	61	—	2	—	—
2nd „	—	—	—	94	—	2	—	—
3rd „	—	—	—	62	—	1	—	—
4th „	—	—	—	45	—	—	—	—
5th „	—	—	—	37	—	1	—	—
6th „	—	—	—	55	—	1	—	—
7th „	—	—	—	49	—	—	—	—
8th „	14	—	—	40	—	—	—	—
9th „	57	—	—	35	—	—	—	—
10th „	139	—	—	15	—	—	—	—
11th „	195	—	—	9	—	—	—	—
12th „	225	—	—	10	—	—	—	—
13th „	279	—	—	4	—	—	—	—
14th „	198	—	—	5	—	—	—	—
15th „	94	—	—	2	—	2	—	—
16th „	34	—	—	1	—	2	—	—
17th „	27	—	—	1	—	—	2	—
18th „	20	—	—	4	—	—	1	—
19th „	12	—	—	3	—	—	2	—
20th „	16	—	—	1	—	2	1	—
21st „	7	—	—	5	—	—	2	—
22nd „	17	—	—	9	—	2	2	—
23rd „	13	—	—	22	—	1	3	—
24th „	15	—	—	42	—	1	3	—
25th „	34	—	—	49	3	1	1	—
26th „	116	—	—	124	—	—	6	—
27th „	99	—	—	152	—	1	14	—
28th „	239	—	—	339	3	5	32	5
29th „	394	—	—	678	6	26	346	46
30th „	445	—	—	783	9	133	904	66
31st „	299		—	926	4	399	1,053	100
32nd „	190		—	823	19	644	781	79
33rd „	234	1,454	—	1,230	10	729	455	45
34th „	325		—	1,272	18	847	265	13
35th „	350		—	1,663	16	1,287	198	5
36th „	309		—	2,026	7	2,050	157	7
37th „	144	—	—	1,682	16	1,549	182	1
38th „	147	—	—	839	29	1,284	150	Returns end.
39th „	43	—	—	434	47	754	177	
40th „	81	—	13	288	66	411	182	
41st „	50	—	30	110	45	249	207	
42nd „	37	—	45	41	83	163	144	
43rd „	61	—	34	25	99	66	112	
44th „	48	—	65	11	102	31	73	
45th „		—	62	6	98	23	67	
46th „	13	—	54	8	72	12	32	
47th „		—	34	2	46	8	8	
48th „		—	20	1	28	7	3	
49th „	—	—	21	—	13	5	1	
50th „	—	—	29	1	11	2	2	
51st „	—	—	31	1	13	3	2	
52nd „	—	—	30	—	10	2	1	
Omitted	155							

* Mr. Grainger's Report to the Board of Health on Cholera, 1848–49.
† Registrar-General's Cholera Report, 1849, p. clxxiv.
‡ Registrar-General's Weekly Returns, 1853–54.
§ *Ibid.* 1866. ‖ *Ibid.* Sept. 8th, 1866, pp. 529–536.

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On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Table VII.—Showing the Deaths from Cholera occurring weekly, during 1865 and 1866, and their Distribution in the Registration Divisions of the Metropolis during the latter year.

Week ending		1865.	1866.	Average of 10 years.	Districts.					
					West.	North.	Central.	South.	Totals.	East.
1st	Jan. 6 -	—	1	·4	—	—	—	—	—	—
2nd	„ 13 -	—	—	·2	—	—	—	—	—	—
3rd	„ 20 -	—	—	·5	—	—	—	—	—	—
4th	„ 27 -	—	1	·1	—	—	—	—	—	—
5th	Feb. 3 -	—	2	·2	—	—	—	—	—	—
6th	„ 10 -	—	—	·3	—	—	—	—	—	—
7th	„ 17 -	—	1	·5	—	—	—	—	—	—
8th	„ 24 -	1	—	·3	—	—	—	—	—	—
9th	March 3 -	—	—	·2	—	—	—	—	—	—
10th	„ 10 -	—	—	·4	—	—	—	—	—	—
11th	„ 17 -	1	—	·2	—	—	—	—	—	—
12th	„ 24 -	1	—	·4	—	—	—	—	—	—
13th	„ 31 -	—	—	·2	—	—	—	—	—	—
14th	April 7 -	—	1	·2	—	—	—	—	—	—
15th	„ 14 -	1	—	·2	—	—	—	—	—	—
16th	„ 21 -	—	—	·4	—	—	—	—	—	—
17th	„ 28 -	1	2	·4	—	—	—	—	—	—
18th	May 5 -	1	1	·3	—	—	—	—	—	—
19th	„ 12 -	1	2	·2	—	—	—	—	—	—
20th	„ 19 -	1	1	·5	—	—	—	—	—	—
21st	„ 26 -	—	2	·1	—	—	—	—	—	—
22nd	June 2 -	1	2	·6	—	—	—	—	—	—
23rd	„ 9 -	1	3	1·7	—	—	—	—	—	—
24th	„ 16 -	3	3	1·2	—	—	—	—	—	—
25th	„ 23 -	11	1	2·8	—	—	—	—	—	—
26th	„ 30 -	11	6	4·5	2	1	—	—	3	3
27th	July 7 -	12	14	6·0	3	1	1	4	9	5
28th	„ 14 -	11	32	7·6	2	4	3	3	12	20
29th	„ 21 -	18	346	13·7	11	6	1	20	38	308
30th	„ 28 -	23	904	15·7	12	20	15	39	86	818
31st	Aug. 4 -	19	1053	16·0	12	46	33	47	138	916
32nd	„ 11 -	11	781	16·1	8	38	23	39	108	673
33rd	„ 18 -	12	455	12·6	7	15	16	48	86	369
34th	„ 25 -	6	265	11·5	3	12	13	39	67	198
35th	Sept. 1 -	4	198	8·4	6	15	9	46	76	122
36th	„ 8 -	9	157	7·0	12	20	12	39	83	74
37th	„ 15 -	4	182	4·0	10	27	20	48	105	77
38th	„ 22 -	3	150	2·9	14	28	19	33	94	56
39th	„ 29 -	4	177	2·5	12	36	28	46	122	55
40th	Oct. 6 -	5	182	1·9	16	37	31	48	132	50
41st	„ 13 -	2	207	1·5	30	38	39	35	142	65
42nd	„ 20 -	4	144	1·9	13	35	27	35	110	34
43rd	„ 27 -	4	112	1·3	8	14	14	50	86	26
44th	Nov. 3 -	2	73	·8	3	8	11	38	60	13
45th	„ 10 -	2	67	·9	1	7	10	33	51	16
46th	„ 17 -	—	32	·2	—	1	5	12	18	14
47th	„ 24 -	—	8	·4	—	1	—	4	5	3
48th	Dec. 1 -	2	3	·7	—	1	—	0	1	2
49th	„ 8 -	—	1	·1	—	—	—	—	—	1
50th	„ 15 -	—	2	·1	—	—	—	1	1	1
51st	„ 22 -	—	2	·0	—	1	—	—	2	1
52nd	„ 29 -	1	1	·2	—	—	—	—	—	1

APPENDIX.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

TABLE VIII.—Showing the DAILY MORTALITY from CHOLERA in the East Districts and rest of the Metropolis, from July 8th to September 1st, 1866.

Date.	East London, including West Ham.	Rest of London.	Date.	East London, including West Ham.	Rest of London.
July 8	0	1	„ 5	119	24
„ 9	0	3	„ 6	115	15
„ 10	0	0	„ 7	84	18
„ 11	3	3	„ 8	93	22
„ 12	6	2	„ 9	91	11
„ 13	12	6	„ 10	72	7
„ 14	11	4	„ 11	67	9
„ 15	12	3	„ 12	71	15
„ 16	31	3	„ 13	44	13
„ 17	54	6	„ 14	38	7
„ 18	59	5	„ 15	50	20
„ 19	83	9	„ 16	44	15
„ 20	91	6	„ 17	38	13
„ 21	104	14	„ 18	39	12
„ 22	104	11	„ 19	24	6
„ 23	130	14	„ 20	31	10
„ 24	144	9	„ 21	24	9
„ 25	166	17	„ 22	25	12
„ 26	155	15	„ 23	30	3
„ 27	125	18	„ 24	20	9
„ 28	157	16	„ 25	11	13
„ 29	151	18	„ 26	23	11
„ 30	141	17	„ 27	21	9
„ 31	171	29	„ 28	15	8
August 1	170	34	„ 29	23	13
„ 2	155	24	„ 30	10	12
„ 3	114	18	„ 31	7	16
„ 4	112	15	Sept. 1	8	15

TABLE IX.—Showing the RELATIVE MORTALITY from CHOLERA in the different Registration Districts of the Metropolis in the Epidemics of 1832–3, 1849, 1854, and 1866.*

Districts.	Deaths to 10,000 inhabitants.				Mean annual mortality from all causes in 20 years: 1841–60.
	1832–33.	In 1849.	In 17 weeks ending Nov. 4th 1854.	In 1866.	
Kensington - - -	10	24	35	3·7	19
Chelsea - - -	80	46	47	3·3	26
St. George Hanover Sq. -	10	18	38	1·7	19
Westminster - -	50	68	60	6·2	26
St. Martin-in-the-Fields-	—	37	24	4·2	23
St. James Westminster -	—	16	152	3·5	23
Marylebone - - -	30	17	16	3·0	24
Hampstead - - -	—	8	11	·8	17
Pancras - - -	20	22	13	6·0	22
Islington - - -	10	22	8	4·3	20
Hackney - - -	2	25	11	10·6	19
St. Giles - - -	50	53	21	9·2	27
Strand - - - -	1	35	24	6·6	24
Holborn - - -	10	35	5	5·2	26
Clerkenwell - - -	10	19	9	7·0	23
St. Luke - - -	30	34	9	8·1	27
East London - -	50	45	23	15·7	27
West London - -		96	10	18·8	27
London City - -		38	14	5·0	22
Shoreditch - - -	10	76	20	10·7	25
Bethnal Green - -	50	90	20	60·4	24
Whitechapel - -	110	64	40	84·2	28
St. George-in-the-East -	30	42	30	87·9	29
Stepney - - - -	50	47	32	107·6	27
Mile End Old Town -				67·7	24
Poplar - - - -	40	71	38	90·8	23
St. Saviour Southwark -	120	153	134	7·4	29
St. Olave Southwark -		181	162	8·5	
Bermondsey - - -	70	161	158	5·3	27
St. George Southwark -	—	164	101	6·6	28
Newington - - -	40	144	101	2·8	25
Lambeth - - -	40	120	63	6·5	24
Wandsworth - -	10	100	77	4·8	22
Camberwell - - -	30	97	91	5·6	23
Rotherhithe - - -	10	205	147	8·7	26
Greenwich - - -	20	75	53	19·5	25
Lewisham - - -	—	30	20	6·1	18
Stratford - - -	—	—	—	77·6	—
West Ham - - -	—	—	—	49·3	—
Leyton - - -	—	—	—	13·1	—

* I have adopted this Table, with the exception of the column for 1866, from a very able article in the "Lancet" for January 26th, 1867, p. 125.

TABLE X.—Showing the WATER COMPANIES supplying each of the PARISHES and DISTRICTS constituted under the Provisions of the METROPOLITAN MANAGEMENT ACT, NUMBER of HEALTH OFFICERS, AREA in Statute Acres, ANNUAL VALUE of PROPERTY assessed in 1866, ESTIMATED POPULATION in 1866, DEATHS, and the RATE of MORTALITY to 10,000 Population from ALL CAUSES and from CHOLERA and DIARRHŒA, DENSITY of POPULATION, ELEVATION, and ANNUAL VALUE of PROPERTY per HEAD of POPULATION. (*Registrar General's Summary of Weekly Returns*, 1866, *pp.* xviii. xix).

Water Company furnishing chief Supply.	PARISHES AND DISTRICTS constituted under the Provisions of the Metropolis Management Act, 18 & 19 Vict. cap. 120.	Number of Health Officers.	Area in Statute Acres.	Annual Value of Property assessed in 1866.	Estimated Population in 1866.	DEATHS IN 1866 FROM All Causes.	Cholera.	Diarrhœa.	Cholera and Diarrhœa.	RATE OF MORTALITY per 10,000 in 1866. All Causes.*	Cholera.†	Diarrhœa.	Cholera and Diarrhœa.	Persons to an Acre in 1866.	Elevation in Feet above Trinity High-water Mark of the Thames.	Annual Value of Property per Head of Population.
	LONDON - - - - -	47	77,997	£ 15,261,999	3,037,991	80,129	5,577	3,184	8,761	264·7	18·4	10·5	28·9	39·0	39	£ 5·006
	WEST DISTRICTS.															
J. W. M.	Paddington - - - - - -	1	1,245	758,344	93,365	1,720	26	80	106	174·4	2·8	8·6	11·4	75·0	78	8·122
W.M.c.	Kensington - - - - - -	1	1,942	501,132	85,171	1,962	18	106	124	229·6	2·1	12·4	14·5	43·9	23	5·884
WM.J.c.	Fulham - - - - - - -	1	4,155*w*	171,876	48,657	1,153	41	65	106	249·2	8·4	13·4	21·8	11·7	7	3·532
J.W.M.c.	*Kensington Registration District*	*3*	*7,342w*	*1,431,352*	*227,193*	*4,835*	*85*	*251*	*336*	*211·1*	*3·7*	*11·0*	*14·7*	*30·9*	*40*	*6·300*
C.	Chelsea - - - - - - -	1	865*w*	299,898	65,957	1,704	22	48	70	269·4	3·3	7·3	10·6	76·3	12	4·546
J. C.	St. George Hanover Square - -	2	1,161*w*	1,076,272	94,315	1,907	18	50	68	181·0	1·7	5·3	7·0	81·2	34	11·411
C.	Westminster - - - - - -	1	917*w*	341,116	68,268	1,884	42	69	111	266·9	6·2	10·1	16·3	74·4	3	4·997
N.c.	St. Martin-in-the-Fields - -	1	305*w*	265,336	21,370	565	9	25	34	245·4	4·2	11·7	15·9	70·1	38	12·416
J. N.	St. James Westminster - - -	1	164	462,032	34,155	797	12	15	27	248·0	3·5	4·4	7·9	208·3	58	13·527
	NORTH DISTRICTS.															
WM.J.	Marylebone - - - - - -	1	1,509	1,053,748	159,871	4,129	54	181	235	255·6	3·0	11·3	14·3	105·9	87	6·591
N. WM.	Hampstead - - - - - -	1	2,252	147,624	23,557	395	2	15	17	178·2	·8	6·4	7·2	10·5	350	6·267
N.H.WM.	Pancras - - - - - - -	1	2,716	925,872	211,825	5,248	138	205	343	241·7	6·0	9·7	15·7	78·0	73	4·371
N.	Islington - - - - - - -	1	3,127	777,632	193,648	5,135	120	167	287	225·9	4·3	8·6	12·9	61·9	94	4·016
N.E.	Hackney - - - - - - -	1	3,929	370,616	97,120	2,394	103	74	177	250·3	10·6	7·6	18·2	24·7	53	3·816
	CENTRAL DISTRICTS.															
N.	St. Giles - - - - - - -	1	245	277,412	52,226	1,502	48	84	132	305·7	9·2	16·1	25·3	213·2	68	5·312
N.	Strand - - - - - - -	1	172*w*	290,808	40,883	1,126	29	29	58	258·2	6·6	7·1	13·7	237·7	50	7·333
N.	Holborn - - - - - - -	1	196	231,875	42,556	1,253	22	72	94	313·0	5·2	16·9	22·1	217·1	53	5·449
N.	Clerkenwell - - - - - -	1	380	242,524	63,957	1,661	45	93	138	276·1	7·0	14·5	21·5	168·3	65	3·792
N.	St. Luke - - - - - - -	1	220	186,452	56,710	1,487	46	75	121	313·3	8·1	13·2	21·3	257·8	51	3·288
N. E.	East London - - - - - -	1	153	2,137,791	37,661	773	59	29	88	248·4	15·7	7·7	23·4	246·2	40	20·778
N.	West London - - - - - -		138*w*		25,470	1,116	60	28	88	276·5	11·8	11·0	22·8	184·6	29	
N.	London City - - - - - -		434*w*		39,756	659	20	15	35	222·3	5·0	3·8	8·8	91·6	31	

	EAST DISTRICTS.															
N. E.	Shoreditch	1	646	386,044	136,836	3,411	135	145	280	250·3	10·7	10·6	21·3	211·8	48	2·821
E.	Bethnal Green	1	760	192,116	110,289	3,824	614	181	795	368·6	60·4	16·4	76·8	145·1	38	1·742
E. N.	Whitechapel	1	406*w*	277,748	76,386	3,499	900	123	1,023	387·0	84·0	16·1	100·1	188·1	32	3·636
E.	St. George-in-the-East	1	243	196,745	47,779	1,877	387	82	469	417·6	87·9	17·2	105·1	196·6	21	4·118
E.	Stepney (Limehouse)	1	576*w*	234,804	56,198	1,849	557	111	668	375·1	107·6	19·8	127·4	97·6	11	4·178
E.	Mile End Old Town	1	681	191,056	80,695	2,427	503	98	601	318·7	67·7	12·1	79·8	118·5	30	2·368
E.	Poplar	2	2,918*w*	344,320	99,762	3,687	835	187	1,022	362·1	90·8	18·7	109·5	34·2	8	3·451
	SOUTH DISTRICTS.															
S. L.	St. Saviour Southwark	1	250*w*	164,000	36,422	910	32	38	70	253·8	7.4	10·7	18·1	145·7	3	4·503
S.	St. Olave Southwark	1	169*w*	110,700	18,914	947	20	19	39	260·1	8·5	10·0	18·5	111·9	4	5·853
S.	Rotherhithe	1	886*w*	83,500	28,767	600	25	17	42	221·7	8·7	5·9	14·6	32·5	0	2·903
S. L.	Bermondsey	1	688*w*	150,000	64,310	1,623	34	82	116	268·3	5·3	12·8	18·1	93·5	0	2·332
S. L.	St. George Southwark	1	282	146,000	57,498	1,551	38	47	85	286·7	6·6	8·2	14·8	203·9	0	2·539
L. S.	Newington	1	624	240,000	92,680	2,240	26	53	79	235·7	2·8	5·7	8·5	148·5	1	2·590
L. S.	Lambeth	1	4,015*w*	637,000	174,904	4,173	114	180	294	253·6	6·5	10·3	16·8	43·6	3	3·642
S. L.	Wandsworth	5	11,695*w*	361,400	82,979	2,075	40	67	107	265·8	4·8	8·1	12·9	7·1	24	4·355
S. L.	Camberwell	1	4,342*w*	250,000	81,818	2,050	46	68	114	266·3	5·6	8·3	13·9	18·8	4	3·056
K. S.	Greenwich	1	3,771*w*	274,976	97,473	2,481	202	74	276	259·3	20·7	7·6	28·3	25·8	9	2·821
K.	Woolwich	None	1,596*w*	83,000	47,363	915	80	43	123	205·4	16·9	9·1	26·0	29·7	?	1·752
K. S.	*Greenwich Registration District*	*1*	*5,367w*	*357,976*	*144,836*	*3,396*	*282*	*117*	*399*	*241·7*	*19·5*	*8·1*	*27·6*	*27·0*	*8*	*2·472*
K.	Plumstead and Charlton	4	11,806*w*	183,850	67,047	933	44	35	79	147·9	6·6	5·2	11·8	5.7	?	2·748‡
L.	Lewisham	1	5,418*w*	227,410	23,373	487	11	9	20	221·5	4·7	3·9	8·6	4·3	89	6·663§
K. L.	*Lewisham Registration District*	*5*	*17,224w*	*411,260*	*90,420*	*1,420*	*55*	*44*	*99*	*166·9*	*6·1*	*4·9*	*11·0*	*5·2*	*28*	*4·548*
	ADDENDUM. EXTRA-METROPOLITAN.															
E.	*Stratford*	—	*8,648*	—	*19,855*	—	*154*	—	—	—	—	*77·6*	—	—	—	—
E.	*West Ham*	—		—	*40,957*	—	*202*	—	—	—	—	*49·3*	—	—	—	—
E.	*Leyton*	—	*4,245*	—	*8,413*	—	*11*	—	—	—	—	*13.1*	—	—	—	—

The area, marked thus (*w*) include water.

The several water companies are designated by letters: thus, the New River Company by N., the Grand Junction by J., Chelsea by C., West Middlesex by W.M., East London by E., Hampstead by H., Southwark by S., Lambeth by L, and Kent by K. In cases where a district is supplied by more than one company, the initial of the company supplying the greater part is placed first. Where a company supplies only a small part of the district it is indicated by a small initial letter.

That part of Hackney District served by the East London Company is, it is believed, supplied from Lea Bridge after filtration; the East Districts are supplied principally from the reservoirs at Old Ford.

* In deducing the mortality from all causes in the several districts, the population and the deaths in the following Hospitals were subtracted from the population and deaths of the respective districts in which the Hospitals were situated, viz., St. Mary's Paddington, inmates 191, deaths 191; Consumption, inmates 218, deaths 127; West London, inmates 23, deaths 13; St. Georges,' inmates 376, deaths 343; Westminster, inmates, 171, deaths 174; Charing Cross, inmates 102, deaths 74; Middlesex, inmates 320, deaths 292; University College, inmates, 154, deaths 211; Royal Free, inmates 101, deaths 129; Small-pox, inmates 35, deaths 260; London Fever, inmates 44, deaths 668; King's College, inmates 164, deaths 234; St. Bartholomew's, inmate 788, deaths 565; London, inmates 405, deaths 733; Guy's, inmates 675. deaths 541; St. Thomas's, inmates 539, deaths 197; and the Dreadnought, inmates 202, deaths 108. The numbers of inmates returned are those enumerated at the census of 1861, but the accuracy of the results are not materially affected by adopting those numbers. The Hospital population and deaths were then distributed proportionally over all the districts of the metropolis. The workhouse of the district of St. Luke is in Shoreditch, the workhouse of the Strand is in St. Pancras, the workhouses of the City of London District are in Mile End Old Town and Poplar Districts, and so on for other outlying workhouses. In calculating the mortality of the respective districts from all causes, the deaths and population of these outlying workhouses were taken from those districts in which they happen to be situated, and placed to the districts to which the inmates belong.

† The following corrections have been made in calculating the Cholera mortality of certain districts wherein Hospitals are situate; the deaths in the London and Cholera Hospitals at Whitechapel of persons belonging to other districts have been distributed proportionally over each of the East London Districts; the Cholera mortality of the districts of St. George Hanover Square, Marylebone, St. Saviour and St. Olave Southwark, Strand, Islington, West London, and Pancras, has been calculated on the deaths from Cholera exclusive of the deaths in the Hospitals of persons brought from other districts.

‡ The annual value of property per head of population in Plumstead District is exclusive of Mottingham Hamlet. Under the provisions of the Metropolis Management Act, Mottingham is excluded from Plumstead, but for registration purposes it is excluded.

§ The annual value of property per head of population of Lewisham District is inclusive of Penge Hamlet. Under the provisions of the Metropolis Management Act, Penge is included in Lewisham, but for registration purposes it is excluded.

TABLE XI.—Showing the WEEKLY MEANS of METEOROLOGICAL OBSERVATIONS taken at the ROYAL OBSERVATORY, GREENWICH, during the Six Months ending the 1st December 1866. (Extracted from the Registrar General's Weekly Returns.)

1866. WEEK ENDING	BAROMETER. Mean weekly reading (corrected and reduced to 32 degr. Fahrenheit.)	THERMOMETERS. Dry. Highest.	Dry. Lowest.	Dry. Range in day.	Dry. Mean weekly value.	Dew Point. Mean weekly value.	Highest in sun, as shown by a self registering Thermometer, read at 9h. p.m.	Lowest on grass, as shown by a self registering Thermometer, read at 9h. p.m.	In Water of Thames at Greenwich, by self-registering Thermometers, read at 9 o'clock next morning. Highest.	Lowest.	DIFFERENCES. Between Dew Point Temperature and Air Temperature. Mean weekly value.	Greatest.	Least.	Between mean temperature of the week and mean temperature of the same week on average of 50 years.	Degree of Humidity, complete Saturation being represented by 100.	WIND. As deducted from Anemometers. Osler's. General Direction. A.M. P.M.	Robinson's. Amount of Horizontal Movement of Air each week.	RAIN. In inches read at 9h.p.m. collected on the ground.	Ozone.
	in.	°	°	°	°	°	°	°	°	°	°	°	°	°			Miles.		
9th June	29·878	73·3	52·4	20·9	61·0	54·1	128·4	49·0	(6 days) 62·0	(6 days) 61·2	6·9	16·0	1·6	+ 3·7	78	S.W.	Sum 1458	Sum 1·48	1·7
16th ,,	29·710	69·8	50·2	19·6	58·5	51·6	124·2	43·9	64·2	62·7	7·0	14·0	2·2	— 0·2	78	S.W. & W.S.W.	Sum 2176	Sum 0·14	1·1
23rd ,,	29·705	70·2	49·8	20·5	58·1	51·1	129·4	45·7	61·3	60.4	7·0	16·4	2·2	— 1·6	78	S.W.	Sum 1956	Sum 0·12	—
30th ,,	29·844	79·9	55·8	24·0	66·3	58·1	142·4	(6 days) 51·7	66·6	64·9	8·2	18·6	0·7	+ 4.8	75	N.E. & N.N.E.	Sum 1330	Sum 0·21	0·3
7th July	29·410	67·8	50·3	17·5	56·3	50·3	133·4	46·8	66·1	65·1	6·1	14·4	0·9	— 5·1	81	S.W. & W.S.W.	Sum 2147	Sum 1·18	1·0
14th ,,	30·038	80·9	56·5	24·4	68·2	60·5	140·2	52·9	66·0	65·1	7·7	17·6	0·8	+ 6·3	77	Variable.	Sum 1320	Sum 0·00	—
21st ,,	29·894	74·8	52·5	22·4	62·2	54·1	130·2	48·4	68·1	67·0	8·1	17·5	2·1	+ 0·2	75	N.E. & E.N.E.	Sum 1335	Sum 0·00	—
28th ,,	29·842	69·3	52·1	17·2	59·3	52·3	118·0	(6 days) 49·3	(6 days) 65·1	(6 days) 64·4	7·0	14·8	2·3	— 2·5	78	Variable.	Sum 1312	Sum 0·09	—
4th Augt.	29·556	69·4	51·7	17·7	58·8	52·1	115·6	49·1	62·6	(6 days) 61·9	6·7	13·5	1·8	— 3·6	79	W. & W.N.W.	Sum 2559	Sum 0·51	—
11th ,,	29·561	67·0	50·4	16·6	57·7	49·6	118·6	44·4	60·7	59·6	8·1	17·1	2·2	— 4·4	75	S.W. & N.W.	Sum 2437	Sum 0·59	1·9
18th ,,	29·680	67·6	52·0	15·6	58·0	50·7	110·2	47·9	61·4	60·4	·3	14·4	2·3	— 3·5	77	Variable.	Sum 1646	Sum 0·62	0·4
25th ,,	29·773	71·8	52·8	19·0	61·2	57·0	111·2	49·7	61·5	60·6	·2	11·9	0·5	+ 0·5	86	Variable.	943	0·32	1·3

Table showing the Weekly Returns of Meteorological Observations taken at the Royal Observatory, Greenwich—*continued.*

1866. Week ending	Barometer. Mean weekly reading (corrected and reduced to 32 degr. Fahrenheit.)	Thermometers. Dry. Highest.	Dry. Lowest.	Dry. Range in day.	Dry. Mean weekly value.	Dew Point. Mean weekly value.	Highest in sun, as shown by a self registering Thermometer, read at 9h. p.m.	Lowest on grass, as shown by a self registering Thermometer, read at 9h. p.m.	In Water of Thames at Greenwich, by self-registering Thermometers, read at 9 o'clock next morning. Highest.	In Water of Thames. Lowest.	Differences. Between Dew Point Temperature and Air Temperature. Mean weekly value.	Greatest.	Least.	Between mean temperature of the week and mean temperature of the same week on average of 50 years.	Degree of Humidity, complete Saturation being represented by 100.	Wind. As deducted from Anemometers. Osler's. General Directions. A.M. / P.M.	Robinson's. Amount of Horizontal Movement of Air each week.	Rain. In inches read at 9h. p.m. collected on the ground.	Ozone.
	in.	°	°	°	°	°	°	°	°	°	°	°	°	°			Miles.		
1st Sept.	29·586	70·1	53·4	16·7	60·2	52·8	122·4	49·0	63·8	63·5	7·4	14·8	1·6	+ 0·5	77	S.W.	Sum 1742	Sum 0·73	1·1
8th „	29·475	66·9	53·1	13·8	58·5	53·8	108·3	48·9	(6 days) 61·1	(6 days) 60·7	4·7	10·3	1·2	+ 0·4	85	S.W.	Sum 2175	Sum 1·91	1·6
15th „	29·544	65·4	51·7	13·7	56·7	50·1	114·4	48·5	60·2	59·6	6·6	12·3	1·5	— 0·7	79	S.W.	Sum 2032	Sum 0·87	2·1
22nd „	29·564	62·7	47·7	15·0	53·7	48·5	107·4	(6 days) 44·0	57·7	56·8	5·3	11·2	1·2	— 2·5	83	S.W.	Sum 1866	Sum 0·88	2·0
29th „	29·677	64·4	48·9	15·5	55·5	52·4	101·2	(6 days) 42·9	55·6	(6 days) 54·7	3·1	8·8	0·2	+ 0·9	89	Calm & S.E.	Sum 894	Sum 0·23	1·7
6th Oct.	29·998	62·7	55·0	7·8	57·9	56·2	78·3	53·5	58·1	57·5	1·7	4·6	0·3	+ 4·3	94	N. & N.E.	Sum 985	Sum 0·02	0·3
13th „	29·998	59·8	46·3	13·5	52·4	48·6	92·8	41·6	57·6	56·7	3·8	9·2	0·8	+ 0·8	87	N.E.	Sum 1251	Sum 0·00	1·1
20th „	29·924	56·9	43·2	13·7	49·6	46·4	84·0	37·6	53·8	52·6	3·2	7·9	1·1	— 0·2	89	Variable.	Sum 1170	Sum 0·85	0·4
27th „	29·791	57·4	42·6	14·8	49·1	46·2	82·7	37·5	53·5	(5 days) 52·7	2·9	7·1	0·5	+ 0·9	90	Variable.	Sum 1296	Sum 1·13	1·1
3rd Nov.	29·843	55·4	43·4	12·0	49·2	45·8	76·6	37·7	—	—	3·4	8·5	0·7	+ 2·7	88	S.W.	Sum 1980	Sum 0·20	0·4
10th „	29·837	55·2	42·1	13·2	48·4	44·5	84·5	35·8	50·4	48·0	3·9	8·7	0·4	+ 3·2	87	S.W. & W.S.W.	Sum 2581	Sum 0·32	1·0
17th „	29·693	52·3	38·3	14·0	45·6	40·2	64·7	32·7	48·5	46·5	5·4	10·3	2·3	+ 2·4	82	W.S.W.	Sum 2942	Sum 0·58	1·1
24th „	29·838	44·8	32·8	11·9	39·2	34·4	53·8	27·0	41·8	40·2	4·8	8·4	2·7	— 2·2	83	W.S.W. & S.W.	Sum 2255	Sum 0·44	0·4
1st Dec.	29·822	44·3	33·6	10·7	38·7	33·7	53·4	28·5	42·2	39·5	5·0	8·4	2·2	— 2·7	82	Variable.	1648	0·20	0·0

APPENDIX.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

CHEMICAL ANALYSIS OF THE WATER SUPPLIED BY THE EAST LONDON COMPANY, JULY AND AUGUST 1866, AND THROUGHOUT THE YEAR.

Professor Frankland, F.R.S., made a special analysis of the water supplied by the East London Company on the 1st August 1866, for the Registrar-General. The following were the results obtained, together with those yielded by the water supplied by the same company on the 1st July, and on the average of the whole year.

	Solid Matter in 100,000 parts.	Organic and other volatile Matter in 100,000 parts.	Oxygen required to oxidise the organic Matter.	Degree of Hardness.
East London Company's Water, collected 1st August 1866.	26·14	1·44	·0328	17·7°
East London Company's Water, collected 1st July 1866.	24·38	1·94	·0344	16·0
East London Company's Water, (average of one year).	27·98	1·62	·0504	21·12

Professor Frankland remarks that :—"It is the amount of organic "matter contained in this water which is of especial importance in "connexion with the outbreak of cholera in the district supplied by this "company. The above results show that, in this respect, the water "supplied on the 1st of August is considerably better than that supplied "on the 1st of July, when the amount of this ingredient was markedly "above the average. Chemical analysis, therefore, although it shows "a larger quantity of organic matter than ought to be contained in "water used for drinking purposes, does not reveal any exceptional "degree of pollution in this water. It must be borne in mind, how- "ever, that chemical investigation is utterly unable to detect the pre- "sence of choleraic poison amongst the organic impurities of water, "and there can be no doubt that this poison may be present in quantity "fatal to the consumer, though far too minute to be detected by the "most delicate chemical research."—(*Weekly Return of Registrar-General*, 4*th August* 1866, p. 279.)

The analysis, of which the results are given in the following Table, was made on the 9th August 1866.

Place of Collection.	Solid Matter in 100,000 parts.	Organic and other volatile Matter (included in previous col.)	Amount of oxygen required for oxidation of organic Matter.	Appearance of Water.
Uncovered North Reservoir.	24·64	1·07	·0452	Slightly turbid, and of a milky appearance.
Uncovered South Reservoir.	25·56	1·53	·0564	Slightly turbid and milky.
River Lea at Old Ford	39·03	3·73	·2792	Very turbid. Suspended matter ·36 in 100,000 parts of the water.
Main leading from pumping engine at Old Ford. Water supplied to consumers.	25·91	1·14	·0204	Transparent.
Essex Well, Lea Bridge	24·85	1·19	·0220	Transparent.

Place of Collection.	Solid Matter in 100,000 parts.	Organic and other volatile Matter (included in previous col.)	Amount of oxygen required for oxidation of organic Matter.	Appearance of Water.
Unfiltered water from special canal at Lea Bridge.	27·39	1·71	·0404	Greenish; slightly turbid.
Main in Stewart's Buildings, High Street, Bromley, where cholera had caused great mortality.	24·94	1·54	·0268	Dirty, depositing more sediment than the sample of unfiltered water from the canal at Lea Bridge.
Cistern at the Police Station, Poplar.	26·34	1·20	·0256	Transparent.

Upon these results Professor Frankland remarks:—

"A comparison of the results yielded by the water from the canal at Lea Bridge with those obtained with the same water taken from the Essex well, after filtration, shows the important extent to which the water is purified by passage through the filtering reservoirs. The substitution of unfiltered for filtered water would at once increase the organic matter supplied to consumers to the extent of 43 per cent. With the exception of the dirty sample drawn from the company's main at Stewart's Buildings, and which contained the same amount of organic impurity as the water of the uncovered south reservoir at Old Ford, none of the samples of water upon the company's premises exhibit, in comparison with the Thames water supplied to the Metropolis, any excessive amount of impurity; but, as I have already pointed out in a previous report, chemical analysis, like every other mode of investigation, is powerless to detect the presence of matter like the choleraic poison amongst the organic impurities of water, for this poison may be present in quantity fatal to the consumer though far too minute to be detected by the most delicate chemical research."—(*Weekly Return of Registrar-General*, 1*st Sept.* 1866, *p.* 453.)

Chemical Analysis of Water drawn from the Main at the London Hospital, and supplied from East London Company's Reservoirs at Old Ford, 1866. By H. Letheby, M.B., M.A., Ph.D., &c., Medical Officer of Health to the City of London.

1866.	Carbonate of Lime.	Sulphate of Lime.	Alkaline Chloride.	Alkaline Nitrate.	Silica, &c.	Oxidisable organic matter.	Total per gallon
January - -	12·8	4·3	1·7	4·4	0·5	0·6	24·3
February - -	14·7	4·5	1·6	1·0	0·6	0·6	23·0
March - -	15·6	4·4	1·0	1·3	0·6	0·4	23·3
April - -	13·5	3·4	1·3	2·6	0·4	0·4	21·6
May - -	13·1	2·8	1·5	3·6	0·3	0·4	21·7
June - -	11·2	2·0	1·1	2·0	0·5	0·4	17·2
July - -	12·0	2·4	1·3	1·5	0·5	0·4	18·1
August - -	11·5	3·1	1·5	1·3	0·3	0·6	18·2
September - -	13·1	2·5	1·3	0·9	0·4	0·4	18·5
October - -	10·2	3·4	1·6	2·3	0·6	0·7	18·6
November - -	15·0	3·0	1·0	2·0	0·4	0·7	22·1
December - -	14·3	4·2	1·4	2·0	0·5	1·2	23·5
Twelve months ending July 1866.	12·8	3·5	1·6	1·8	0·5	0·5	20·7

Appendix.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Geological Note by Mr. Whitaker.

NOTE ON THE SURFACE-GEOLOGY OF LONDON; with LISTS OF WELLS AND BORINGS, showing the Thickness of the Superficial Deposits; by WILLIAM WHITAKER, B.A. (Lond.), F.G.S., OF THE GEOLOGICAL SURVEY OF ENGLAND.

CONTENTS.

1. DESCRIPTIVE NOTE.

This short note is only meant as an explanation to the list of wells and borings, which list it was thought would be more easily understood if prefaced by some account of the beds through which the sections were made.

It would be tedious and out of place to acknowledge here the many sources, either from published works or from personal information, whence the accounts of the wells, &c. have been derived, and I need only say that the borings along the lines of the great sewers have been taken from the large "Contract Drawings" of the Metropolitan Board of Works. Of course all the lists are simply abstracts of the sections, and treat only of the beds near the surface; the details would make a small volume.

As the whole has been written somewhat hastily, and at short notice, there may be many omissions; but I think that a very fair notion of the thickness and nature of the surface-deposits of London may be got from the lists and the description.*

The geology of London is fairly simple, both as to the number and the arrangement of the beds †, but of this I need not now treat; it will be enough for the present purpose to give a short account of the different deposits on which London is built. These may here be classed under four heads:—Modern Deposits, whether natural or artificial; Valley Drift, which, though of late age geologically, is not so in the ordinary sense; Old Tertiary Beds (chiefly London Clay), immeasurably older than the foregoing, but classed nevertheless amongst the newer geological formations; and the Chalk.

London is placed in a very broad valley cut out in the London Clay, &c., to a very small extent refilled by the Valley-drifts; and then again slightly cut down in parts.

A. MODERN DEPOSITS.

The word "modern" is applied in geology to anything that has taken place since the present order of things has existed; that is to say to everything of historic age.

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* A detailed account of the geology of the western half of London has been given in the "Geological Survey Memoir on Sheet 7" (1864), and the eastern part will be dealt with in like manner in the Memoir on Sheet 1.

† For a good general account see Mr. Prestwich's capital little book "The Ground Beneath Us," Van Voorst, 1857.

1. *Made Ground.*

Under this head are grouped the various accumulations made either purposely or incidentally during the growth of a large city, from the destruction of buildings, from the constant addition of "road-metal," from the filling up of hollows, from the improvement of low damp ground by an artificial covering of dry rubbish and gravel,* and from other like causes.

For the most part such deposits are permeable by water, and might be considered as an impure gravel.

2. *Alluvium.*

But a small part of London is built on modern river-deposit, and it is well that it should be so, for there can hardly be worse ground for houses than the low damp flats of clay and peat that fringe streams.

It is somewhat strange that a river as large as the Thames should have formed but a few very narrow strips of alluvial mud for many miles, and should then abruptly take its course through broad tracts of marshland; but to this fact, perhaps, we may look for the reason that determined the site of London. Above the city the river is bordered on either side by gravel, except for some trifling patches of alluvium; below there are broad marshes, the level of which is lower that that of the river at high tide.

The alluvium of the Thames is for the most part clayey, and therefore impervious to water.

B. Valley-drift.

It is needless here to enter into a discussion of the evidence which has led geologists to conclude that the loam (or brickearth) and gravel of our valleys have been made by river-action; enough to say that the valley of the Thames contains a great quantity of such beds, that the greater part of London is built on them, and that they consist, as far as London is concerned, of gravel sand and loam, the first two of which must be grouped together.

3. *Brickearth.*

This loam, or mixture of clay and sand, is more local than the gravel on which it rests, though it nevertheless takes up some space. It is of a brown colour and of no great thickness, but being more or less clayey it tends to prevent water from sinking to the gravel.

4. *Gravel and Sand.*

The gravel of London consists almost wholly of flints and flint-pebbles in a sandy matrix, with occasional beds of sand, which last now and then make up nearly the whole of the deposit. The thickness is sometimes more than 20 feet, and the bed is of course highly permeable to water; indeed from it all the shallow wells are supplied, the clay generally found below not allowing the water to sink further.

Many of the lower districts of the valley of the Thames are less damp than the rising ground of the neighbourhood, because whilst the latter consists simply of clay, in the former there is a capping of gravel on the clay.

[Besides these Valley-drifts there is also a patch of Glacial Drift on the north, in the neighbourhood of Finchley. This is of older date than the former, and may here be divided into two:—(*a*) *Boulder Clay*, a stiff bluish clay with rounded lumps of Chalk and other rocks that show the common signs of glacial action; below which there is generally (*b*) *Gravel*, sandy, and made up chiefly of flint-pebbles.]

* Belgravia, I believe, is in great part built on made ground, otherwise it would be lower and damper.

Geological Note by Mr. Whitaker.

C. OLD TERTIARY BEDS.

5. *Lower Bagshot Sand.*

Two outliers of the fine sharp light-coloured sands which are found in mass in the neighbourhood of Bagshot, Aldershot, &c., occur on the hills of Hampstead and Highgate. This formation is permeable by water, which is often thrown out in springs near the outcrop of the underlying clay.

6. *London Clay.*

This is a stiff bluish-grey or brown clay, often with large nodular masses of clayey limestone known as *septaria*, and is of course impervious to water.

It underlies the gravel, &c., in nearly the whole of London, crops out to the surface along the boundary of the gravel north of the Thames, and to a large extent on the south also, and is cut into (through the gravel) by the shallow valleys of the Serpentine and the Fleet.

7. *Lower London Tertiaries.*

This division consists of a set of pebble-beds, sands, clays, and loams, arranged by geologists in three groups, the whole thickness of which does not exceed 120 feet near London.

The pebble-beds at the top are local, and occur only on the east. They are made up of flint-pebbles and sand, and therefore are permeable to water. (Oldhaven Beds.—" Basement-bed of the London Clay " of Mr. Prestwich.)

The sands, clays, &c., next below, are constant as to their occurrence, but ever varying as to their structure; at one place there being chiefly sand, and at another little but clay. (Woolwich and Reading Beds.)

The sand at the bottom thins to the west and north. It is a water-bearing bed, and many of the London wells have got their supply from it. (Thanet Sand.)

The "Lower London Tertiaries," as a whole, are more or less permeable, though water is sometime held back by the clays. They occur at once below the gravel, &c., on the north of the Thames, in the Isle of Dogs, and Stratford, and on the south they crop out from beneath the London Clay at Dulwich, Peckham, and New Cross, whilst further east, near Greenwich and Woolwich, they form a broad tract. Everywhere some part of the series comes between the London Clay and the Chalk.

D. CHALK.

This well-known soft white limestone is a great absorbent of moisture and therefore conduces to dryness at the surface, whilst being at the same time a reservoir of water underground. From it most of the deep wells of London draw their supply. It occurs everywhere beneath the Tertiary formations, but does not crop out in London, except over a small area near Lewisham and Deptford.

It is needless to describe the tracts taken up by the above beds, as Mr. Radcliffe has added a geological map of London and the neighbourhood to his Report, and the wells and borings of the following lists show what formations underlie the surface-deposits at their respective places.

Besides these borings, many good sections have been made at various times along the lines of the sewers and in other works. Thus the excavations for the Metropolitan Railway from Paddington to beyond Euston Square, showed a mass of gravel, &c., sometimes 20 feet thick, above the London Clay.

2.—LIST of LONDON WELLS, BORINGS, &c., to show the Thickness of the Superficial Deposits.

A. *North of the Thames.*

(The measurements in this and the following lists are in feet.)

———	Made Ground and Soil.	Alluvium.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
Bank of England - - - - - -	22	—	—	4	26	London Clay.
Blackfriars, Apothecaries' Hall - - - -	12	—	—	—	12	"
Blackwall, Trinity Wharf - - - - -	18	—	—	45 !	—	Clay (? London Clay, or does the "gravel" include some of the "pebble-beds" below the London Clay ?)
Bow, Berger's Starch Works - - - -	2	—	3	14	19	London Clay.
Brentford, cutting of South Western Railway at Kew Bridge - - - - - -	1	—	4	16	21	"
" reservoir close to Kew Bridge - - -	—	—	—	—	15	"
Broad Street, Golden Square, Broadwood's Brewery -	—	—	—	$10\frac{1}{2}$	$10\frac{1}{2}$	"
Bromley, Joseph Foster's (an old well) - - -	—	—	—	—	18	"
Camden station, London and North Western Railway -	—	—	—	—	18	"
Chiswick, Griffin Brewery - - - - -	—	—	—	—	40	"
Coldbath Fields Prison - - - - -	23	—	—	7	30	London Clay (? thin and then other clay).
Covent Garden - - - - - -	—	—	—	—	25	London Clay.
Finsbury, White Cross Street - - - -	—	16?	—	3	—	(Not bottomed).
Fishmongers' Hall, Northern End of London Bridge -	27		7	14	48	London Clay.
Golden Lane, City Baths and Washhouses - - -	6	—	—	14	20	"
Hampstead Road, at Reservoir, lately destroyed - -	6	—	—	17	23	"
Horsleydown, Anchor Brewery (Courage & Co.) - -	—	—	—	—	32	"
Hoxton - - - - - - -	—	—	—	—	18	"
Isle of Dogs : Nicholay Graham, & Co., Cumberland Oil Mills	1	—	—	38	39	Under "gravel" is most likely included some of the pebble-beds below the London Clay.
Kensington Brewery - - - -	—	—	—	—	27	——

List of London Wells, Borings, &c., to show the Thickness of the Superficial Deposits—*continued.*

——	Made Ground and Soil.	Alluvium.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
Kensington Gardens (N.E. corner. To supply Serpentine)	2	—	—	—	2	London Clay.
„ Horticultural Society	18	—	—	22	40	„
„ Workhouse	8	—	—	3	11	„
Lea Bridge Waterworks	—	—	—	—	14	„
„ „ (another well)	—	—	—	—	9	„
Limehouse, Lead Island Works	9	—	—	5½	14½	Clay touched.
	6¾			5¾	12½	
„ Union Schools	5	—	11½	—	—	Not bottomed.
Lombard Street, St. Mary's Woolnoth	—	—	—	Thickness not given.	—	London Clay.
London Docks	—	—	—	—	37	„
Long Acre, Combe & Co's Brewery	—	—	—	—	15	„
Mile End, Mann and Crosmann's Brewery	—	—	—	10	10	„
Marylebone Road, Messrs. Staines' Brewery	9	—	—	24½	33½	„
Mile End Road, City of London Union	4	—	2	29	35	„
Millbank, Seager's Distillery	22½	—	—	3	25½	„
Minories, London and Blackwall Railway	15?	—	—	9	24	„
Notting Dale, near Notting Hill	12	—	—	5	17	„
Orange Street, near the National Gallery	15	—	—	15	30	„
Pimlico, Cubitt's Workshop	6	7	—	22	35	„
„ Simpson's Factory, Grosvenor Road	7	—	—	19	26	„
Plaistow Marsh, opposite Woolwich Dockyard	—	12¾	—	23¼	36	Chalk.
Poplar, High Street	—	—	—	—	30	London Clay.
„ „ (end of Woodstock Road)	3	—	—	12	15	„
„ „ (opposite Queen Street)	3	—	—	19	22	„
„ „ (near to Sophia Street)	2	—	—	9½	11½	„
„ „ (opposite the "White Horse")	3	—	—	14	17	„
„ Workhouse, north end, east wing	—	15	—	—	15	Clay.

List of London Wells, Borings, &c., to show the Thickness of the Superficial Deposits—*continued.*

——	Made Ground and Soil.	Alluvium.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
Poplar Workhouse well, Master's garden	2½	7½	—	Sand. 14	—	Gravel.
Ratcliffe, Ravenhill and Co., Glasshouse Fields	13	—	—	6	19	,,
Saint Catherine's Docks	—	—	—	—	40	,,
Shoreditch Workhouse	10	—	—	8	18	London Clay.
,, Truman and Hanbury's Brewery	9	—	6	7½	22½	,,
Stepney, Holt's Brewery	—	—	—	14	14	,,
Stratford, Savill's Brewery	7	—	—	5	12	Clay (? London Clay) thin; then sand (Woolwich Beds).
Tottenham Court Road, Meux's Brewery	—	—	—	—	19	London Clay.
Tottenham Gasworks	3	—	—	11	14	,, (thin).
,, J. Foster's (an old well)	—	—	20		20	London Clay.
,, Warne's India Rubber Works	—	—	—	—	15	,, (thin).
Tower Hill, Royal Mint	11	—	—	13	24	London Clay.
Trafalgar Square, in front of the National Gallery	9	—	—	14	23	,,
West Ham (Union)	—	—	—	16	16	Sand of Woolwich Beds.
,,	8	—	—	9	17	Clay, sand, &c.
West India Docks, south side of Export Dock	15?	—	5	25?	45?	Sand (of Lower London Tertiaries).
Westminster Bridge	27?	—	—	—	27?	London Clay.
Westminster, Cooke's, Swallow Street (an old well)	—	—	18		18	,,
,, Elliott's Brewery	—	—	—	—	32	,,
,, Old Pye Street	6	11½	—	13	30½	,,
,, Thorne's Brewery	—	—	—	—	27½	,,
,, Artillery Brewery, Victoria Street	—	—	—	—	37	,,
Whitechapel, Kirk and Dyck's, Osborne Place	6	—	6	12	24	,,
,, Smith's Distillery	7	—	—	22	29	,,
,, Walton's Sugar House, Angel Court	6	—	—	12	18	,,

List of London Wells, Borings, &c., to show the Thickness of the Superficial Deposits—*continued.*

B. *South of the Thames.*

——	Made Ground and Soil.	Alluvium.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
Balham Hill, near Clapham Common	—	—	4	10	15	London Clay.
Barnes	—	—	—	—	13	”
Battersea, Jones & Co.'s Starchworks, York Road	—	—	—	—	32	”
Blackfriars Road, Duke Street, Stamford Street, Messrs. Clowes, Printers.	8	—	—	18	26	”
Bermondsey Street	—	12	—	20? (sand)	32	”
Deptford Creek, Bridge Road, near the bridge	6	14	—	6	26	Clay.
” Kent Waterworks	—	—	—	—	27	Chalk.
” another boring a few yards off	—	—	—	—	30	”
Garret Copper Mills, near Wandsworth	—	—	—	9	9	London Clay.
Greenwich Hospital	—	10	—	35*	—	* Including some of the pebble-bed of the upper part of the Lower London Tertiaries.
Greenwich Marsh, opposite Green's Dock	20¾	—	—	12	32¾	London Clay?
Lambeth, Bethlehem Hospital	—	—	—	28†	28	† ? Including made ground.—London Clay beneath.
” Charing Cross Railway, William Street	7	1	—	Touched.	—	——
” Goding's Brewery, Belvidere Road	15	—	—	15	30 (or more)	London Clay.
” York Mead	—	—	—	—	30	
Mortlake Brewery	—	—	—	10	10	”
” Randell's, within 100 feet of the Thames (an old well)	—	—	—	20	20	”
Old Kent Road, Cooper's Road	6	2¼?	—	10¼	—	——
” Hatcham Park Road, Five Bells Lane	2	—	8	—	10	Clay and Sand (? gravel).
Plumstead Marsh, E. of the practice-butt, Royal Arsenal	—	24	—	11	35	Thanet Sand; then Chalk.
Rotherhithe, under a shed at the Globe Dock	12?		—	23½	35½?	
South Eastern Railway, Angerstein's Wharf	—	7	—	12	19	Chalk.
Southwark, Barclay's Brewery	21		—	6½	27½	London Clay.
” Guy's Hospital	8	6	—	19	33	”
Stockwell Green, British Brewery (Waltham's)	—	—	—	15	15	”
Walworth, Lorrimore Road, near Surrey Zoological Gardens	1	—	—	15¼	—	——

3.—BORINGS.

N.B. The figures and letters preceding the localities of the borings are the same as those in the "Contract Drawings" of the Metropolitan Board of Works, from which the facts are taken.

(A.) *North of the Thames.*

(*a*) *Borings along the Line of the* "OUTFALL SEWER, NORTH SIDE."

——	Made Ground and Soil.	Alluvium.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
53–80. Across the "Thames Marshes (East Ham Level)," through alluvial clay and peat to gravel. (The gravel under the alluvium of the Thames is always saturated and bleached.)						
46–52. Across the flat of valley gravel, &c. S. of East Ham. Through "surface-earth," loam, and gravel.						
45. About ½ mile westward of East Ham Church - -	1	—	3	7	11	Clay.
42–44. Between Plaistow and East Ham, gravel, sand, and clay						
41. S. of the middle of Tun Marsh Lane - - -	—	—	—	13?	13	"
32–40. S.E., S. & W. of Plaistow, in gravel, &c., with a little surface-earth.						
31? Near railway S. of West Ham - - - -	3	—	1	9	13	"
28–30. From the above westward to just W. of North Woolwich Railway. Through a little surface earth and clay, and then gravel.						
27. E. side of streams. Abbey Mill Toll Bar - - -	4½	6	—	5	15½	"
26. Between " " " - - -	10	8 or more	—	—	18	"
25. W. side of " " " - - -	10	10	—	2	22	"
1–24. From S. of Abbey Mill Toll Bar to the River Lea, a little S. of Old Ford Lock. Through "surface-earth" and alluvial clay and peat of the Lea to gravel.						

(*b*.) BORINGS along the Line of the "LOW LEVEL SEWER, NORTH SIDE," MAIN LINE.

—	Made Ground and Soil.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1. A little S. W. of Abbey Mill Toll Bar - - - -	2 or 4	—	12 or 14	16	Clay 2 feet, then sand 25 feet, then clay.
2. „ „ N. E. of "Three Mills and Bridge" - - - -	6½	—	19	22	Clay.
3. „ „ W. „ „ „ - - - - - -	9	—	2	11	„
4. „ „ S. of junction of Three Mills Lane and Four Mills Street -	3½	—	17½	21	„
5. Between Four Mills Street and East and West India Docks Railway -	2½	—	12½	15	„
6. Junction of Glaucus Street and Devon's Lane. - - -	1	10 (Brick Earth and Gravel and Sand)		11	„
7. A little W. of crossing of Bow Common Lane and railway - -	3½	19½ (Brick Earth and Gravel and Sand)		23	London Clay.
8. Devon's Lane. A little East of North London Railway - -	6	—	7½	13½	„
9. Eastern side of Salmon's Lane Bridge (over Regent's Canal) - -	8½	—	8½	17	„
10. Commercial Road (where the North London Railway crosses) -	5	—	12	17	„
11. Junction of Butchers Row and Brook Street - - -	5½	7	—	12½	Clay.
12. „ „ Devonport Street - - - - - -	15	—	11½	26½	London Clay.
13. Back Road (where joined by continuation of Sutton Street) - -	7	—	18	25	„
14. Junction of Back Road and Cannon Street Road - - -	7	5½	15½	28	„
15. „ „ Cable Street and Leman Street - - - - -	9	—	10	19	„
16. Near western end of Royal Mint Street - - - -	17	—	13	30	„
17. Tower Hill, eastern end of Great Tower Street - - -	5½	—	11½	17	„
18. Eastern end of Eastcheap - - - - - -	15	9	11½	35½	„
19. North of Statue, King William Street - - - -	11	—	25	36	„
20. Cannon Street (where the lane from the Mansion House crosses) -	19	—	—	19	„
21. „ „ (near crossing of street, between Bread Street and Queen Street - - - - - - -	13	—	14	27	„

BORINGS along the Line of the "LOW LEVEL SEWER, NORTH SIDE," HACKNEY WICK BRANCH.

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total depth of Superficial Deposits.	Beds below.
A. Triangle of roads a little south of Bow Bridge - - -	$5\frac{1}{2}$	—	11	$16\frac{1}{2}$	Clay.
B. Corner of Old Ford Road, W. - - - - -	6	—	—	6	"
C. Old Ford Road just North-east of Southern end of Sounding Alley -	3	—	8	11	"
D. " " half way between the above and Old Ford Lock -	3	—	2	5	"

(*c.*) BORINGS on the Line of the "MIDDLE LEVEL SEWER, NORTH SIDE," MAIN LINE.

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total depth of Superficial Deposits.	Beds below.
1. Near to, and about equal distances from Sir G. Duckett's Canal, the North London Railway, and Old Ford Road (close to footpath over Canal) and near Junction with High Level Sewer - -	—	—	—	$5\frac{3}{4}$	London Clay.
2. Old Ford Road, near corner of Beale Road - - - -	$4\frac{1}{2}$	—	$17\frac{1}{2}$	22	"
3. " " (a little east of where it crosses the Canal - -	4	—	$17\frac{1}{2}$	$21\frac{1}{2}$	"
4. Eastern side of Regent's Canal, near Twig Folly Bridge at Old Ford Footpath.	2	—	17	19	"
5. A little west of the Canal, at the end of Green Street - -	4	? 3	$18\frac{3}{4}$	$25\frac{3}{4}$	"
6. Morpeth Street, near Green Street - - - - -	$4\frac{1}{4}$	? 2	$15\frac{3}{4}$	22	"
7. Bethnal Green Road, Eastern end (Cambridge Road) - -	$4\frac{1}{2}$	—	$6\frac{1}{2}$	11	"
8. " " Squerries Street - - - -	$5\frac{3}{4}$	$13\frac{1}{4}$		19	"
9. High Street, Shoreditch, end of Church Street - - -	$4\frac{1}{4}$	$4\frac{1}{2}$	$9\frac{3}{4}$	$18\frac{1}{2}$	"
10. Tabernacle Square, near corner of City Terrace - - -	$11\frac{1}{4}$	?	—	—	"
11. Old Street, near the end of Bunhill Row - - - -	15	—	$4\frac{1}{2}$	$19\frac{1}{2}$	"
12. Junction of Old Street with Goswell Street - - - -	$19\frac{3}{4}$	—	5	$24\frac{3}{4}$	"

Borings on the Line of the "Middle Level Sewer, North Side," Main Line—*continued.*

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
13. St. John Street, north of Wilderness Row - - - -	8¾	—	9¼	18	London Clay.
13b. St. John's Square, near the corner of Albemarle Street - -	21	—	—	21	"
13a. " " Ledbury Place - - - -	9	—	14	23	"
14. Red Lion Street, near the corner of Red Lion Mews - -	8¾	—	5	13¾	"
15. Clerkenwell Green, near South-east corner of Sessions House -	6½	—	9¾	15¼	"
16. Turnmill Street, " " " - -	2½	—	8½	11	"
17. A little west of last, east side of Fleet Sewer, opposite Sessions House	15	4		19	"
18. Western side of Fleet Sewer, at end of Vine Street - - -	16¼	—	3	19¼	"
18a. Little Saffron Hill, near corner of " - - - - -	11¼	—	1¾	13	"
19. Back Hill, at corner of Christopher Street - - - -	8¾	—	6¼	15	"
20. Junction of Leather Lane and Liquorpond Street - - -	10	—	10½	20½	"
21. Crown Court, Liquorpond Street - - - - -	7½	4	3½	15	"
22. At corner of King's Road, Grays Inn Lane - - - -	14½	6	—	20¼	"
23. At junction of Bedford Row and Theobalds Road (junction with Piccadilly Branch sewer) - - - - - -	10½	—	11	21½	"
24. At junction of Kingsgate Street and Orange Street - - -	5¾	6	9½	21¼	"
25. At junction of Hart Street and Museum Street - - -	7¾	2	10½	20¼	"
26. At junction of Oxford Street, and Newman Street - - -	9¾	—	17¾	27½	"
27. Regent's Circus, Oxford Street - - - - -	20½	—	13	33½	"
28. Junction of Oxford Street and Duke Street - - - -	8¼	5¾	—	14	"
29. Junction of Oxford Street and Cumberland Street opposite the Marble Arch - - - - - - -	8	25½		33½	"
f. Bayswater Road, Albion Street - - - - -	5	—	14	19	"
e. " between Albion Street and Hyde Park Street -	4	—	16	20	"
d. " street west of Hyde Park Street - - -	4	—	4	8	"
c. " a little east of Victoria Gate - - -	5½	—	8½	14	"

Borings on the Line of the "MIDDLE LEVEL SEWER, NORTH SIDE," MAIN LINE—*continued.*

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
b. Bayswater Road, Buck Hill Gate - - - - -	$3\frac{3}{4}$	—	6	$9\frac{3}{4}$	London Clay.
a. ,, ,, (E. side of), Grand Junction Road - -	$8\frac{1}{4}$	—	—	—	? Alluvial Clay, &c.
30. ,, ,, opposite Porchester Terrace (W. side) - -	$3\frac{1}{2}$	—	$8\frac{3}{4}$	$12\frac{1}{2}$	London Clay.
31. ,, ,, corner of Pembridge Gardens, near Notting Hill Toll Gate - - - - - - -	$2\frac{1}{2}$	6	15	$23\frac{1}{2}$	,,
32, 33, 34. To the North.—Mould, &c. on London Clay.					
COPPICE ROW BRANCH.					
1. Junction of Coppice Row and Bowling Green Lane - - -	$6\frac{3}{4}$	—	—	$6\frac{3}{4}$	Gravelly Clay, then London Clay.
2. Bagnigge Wells Road (opposite Guildford Street East) - -	$2\frac{1}{4}$	$2\frac{1}{4}$	4	$8\frac{1}{2}$	London Clay.
3. ,, ,, ,, S.S.W. of Granville Place - - -	13	—	—	13	Gravelly Clay, then London Clay.
PICCADILLY BRANCH.					
1. N.E., Corner of Lincoln's Inn Fields - - - - - -	8	—	$11\frac{1}{4}$	$19\frac{1}{4}$	London Clay.
2. Junction of St. Martin's Lane and Long Acre - - -	13	—	? $1\frac{1}{2}$	$14\frac{1}{2}$	,,
3. Piccadilly, Regent Circus - - - - - -	$10\frac{1}{2}$	—	$6\frac{3}{4}$	$17\frac{1}{4}$	,,
4. ,, Half Moon Street - - - - - -	$3\frac{1}{2}$	—	—	$3\frac{1}{2}$	,,

(*d*) BORINGS along the line of the "WESTERN SEWERS."

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1. Corner of King's Road and Bagleys Lane (S.E. of Walham Green)	$2\frac{1}{4}$	$3\frac{3}{4}$	16	22	London Clay.
2. South of St. John's Church, Walham Green	5	—	$25\frac{1}{4}$	$30\frac{1}{4}$	"
3. William Street, nearly half a mile west of above	$3\frac{3}{4}$	—	$17\frac{3}{4}$	$21\frac{1}{2}$	"
4. Fulham Road, opposite Greyhound Lane	$3\frac{1}{4}$	? $13\frac{1}{2}$	$9\frac{3}{4}$	$26\frac{1}{2}$	"
5. Hammersmith, Junction of George Street and Cut Throat Lane	$3\frac{1}{4}$	5	$19\frac{1}{4}$	$27\frac{1}{2}$	"
6. " Upper Mall a little E. of Grove Road	$3\frac{3}{4}$	? $8\frac{1}{4}$	11	23	"
7. King's Road, E. end of Parson's Green (Fulham Branch)	$3\frac{1}{2}$	$3\frac{3}{4}$	$16\frac{1}{2}$	$23\frac{1}{4}$	"
8. Fulham Junction of King's Road and Back Lane	$3\frac{1}{2}$	—	29	$32\frac{1}{2}$	"

(*e*) M.S. BORINGS. (Metropolitan Board of Works.) (N. Side of the River.)

The Letters preceding the Localities of the Borings are the same as those in the M.S. Drawings in the Office of the Board of Works.	Made Ground and Soil.	Alluvium.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
Stoke Newington, Rectory Road } Along the line of the Northern High Level, Lewes.	—	—	2	$22\frac{1}{2}$	$24\frac{1}{2}$	London Clay.
Victoria Park, by Wick Lane } Along the line of the Northern High Level, Lewes.	2	—	4	13	19	"
Wick Lane, Bow, near the River Lea } Along the line of the Northern High Level, Lewes.	—	—	$3\frac{1}{3}$	8	$11\frac{1}{2}$	"
J. $1\frac{1}{4}$ furlongs S.W. of East Ham Tollgate (Barking Road)	3	—	—	$31\frac{1}{2}$	$34\frac{1}{2}$	"
K. 880 feet N.W. of junction of Green Street and the Barking Road	$2\frac{1}{2}$	—	$6\frac{1}{2}$	$2\frac{1}{10}$	$11\frac{1}{4}$	"
L. $2\frac{1}{4}$ furlongs S.S. by E. of Plaistow church	$1\frac{1}{2}$	—	$4\frac{1}{2}$	6	12	"
Q. Devon's Lane, Bromley (just north, of No. 5, boring on the north side low level below the sewer.)	—	—	—	—	$19\frac{1}{4}$	"
R. North London Railway Station, Bow. (This boring must have been made below the natural surface of the ground, as there is much gravel hereabouts.)	—	—	—	5	5	"
S. Regent's Canal, New Mile End Lock	$2\frac{1}{2}$	—	—	22	$24\frac{1}{2}$	"
U. Widnall's Place, Vine Street, Saffron Hill	10	—	5	2	17	"
V. W. } Near Regent's Canal, Cambridge Heath Bridge	6	—	—	20	26	"

M.S. Borings. (Metropolitan Board of Works.) N. Side of the River.

—	Made Ground and Soil.	Alluvium.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
A^1. Along the bank of the Thames. Westminster, Regent Street	6	4	—	23	—	—
B^1. Along the bank of the Thames. Percy Wharf	—	11	—	21	32	London Clay.
C^1. Along the bank of the Thames. Adelphi, Henderson's Wharf	—	—	—	—	20 or $28\frac{1}{2}$	"
D^1. Along the bank of the Thames. Somerset House	—	—	—	20	20	"
E^1. Along the bank of the Thames. West end of Temple Gardens	—	—	—	—	30	"
F^1. Along the bank of the Thames. Waterman's Alley	14	—	—	25	40	"
D^1. Turnstile N.E. corner of Lincoln's Inn Fields (close to boring No. 1. of the "Piccadilly Branch" of the Middle Level Sewer)	9	—	7	$6\frac{1}{2}$	$22\frac{1}{2}$	"
G^1. Bridge Street, Blackfriars, junction with Earl Street	25	1	—	7	33	"
H^1. Rutland Street, Upper Thames Street	2	—	—	—	2	"
I^1. Opposite Paul's bakehouse, Godliman Street	$7\frac{1}{2}$	—	3	16	$26\frac{1}{2}$	"
J^1. Old Fish Street, opposite Moor's yard	10	—	1	$26\frac{1}{2}$	$37\frac{1}{2}$	"
P^1. Charles Street (Back Road) just S. of the Blackwall Railway	4	—	—	$20\frac{1}{2}$	$24\frac{1}{2}$	"
Q^1. White Horse Street, Commercial Road (? same as or close to boring 11 of Low Level Sewer, N. side)	$7\frac{1}{4}$	—	$6\frac{1}{2}$	—	$13\frac{3}{4}$	"
R^1. Dalgleish Street, Commercial Road	$5\frac{1}{2}$	—	—	$10\frac{3}{4}$	$16\frac{1}{4}$	"
S^1. Limehouse Cut, Britannia Bridge	8	—	—	$7\frac{1}{2}$	$15\frac{1}{2}$	"
S^2. Limehouse, Rixbie's Rope Walk	—	—	—	$6\frac{1}{2}$	$6\frac{1}{2}$	"
S^3. Limehouse Lock, near	—	—	—	$7\frac{1}{4}$	$7\frac{1}{4}$	"
S^4. - - -	—	—	—	$15\frac{3}{4}$ (sand)	$15\frac{3}{4}$	"
T^1. Limehouse Causeway, junction with Spread Eagle	$7\frac{1}{2}$	—	5	15	$27\frac{1}{2}$	"
V^1. Limehouse Cut, Stink House Bridge	2	—	$3\frac{1}{2}$	4	$9\frac{1}{2}$	"
V^1. " " Four Mills "	—	—	—	2	2	"
W^1. Corner of Peter Street, Four Mills Street	13	—	—	10	23	"
W^2. Limehouse Cut. W. of Bromley Lock	13	—	—	$8\frac{1}{4}$	$21\frac{1}{4}$	"

Appendix.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Geological Note by Mr. Whitaker.

M.S. BORINGS. (Metropolitan Board of Works.) N. Side of the River—*continued.*

——	Made Ground and Soil.	Alluvium.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
W[3]. Limehouse Cut, N.W. of Bromley Lock - - -	4¼	10¾	—	6½	21½	London Clay.
X[1]. Poplar, in Bow Lane, near junction with High Street	3½	—	—	13	16½	„
Y[1]. Blackwall, N. of West India Dock entrance - -	16	7½	—	26½	(Not bottomed).	
Z[1]. „ S. of South Dock entrance - - -	11¼	20¾	—	15	„	

(*f*) M.S. BORINGS, RIVER LEA NAVIGATION.

The Numbers preceding the Localities of the Borings are the same as those in the large Plan of the River Lea Navigation.	Made Ground and Soil.	Alluvium.	Gravel, &c.	Total.	Beds below.
1 to 16 are above Tottenham.					
17. On E. side of Canal, above Tottenham Mills Lock - - -	1½	4½	11	17	London Clay.
18. „ „ a little below the stream from the former "Copper Mills," Walthamstow - - - - - -	1½	11	17½ (with a little clay).		
19. On E. side of Canal, a little above the high road, Lea Bridge -	1½	11?	18		
20. „ W. „ close below Sir G. Duckett's Canal - -	2	8½	8	18½	Clay.
21. „ „ „ near Old Ford Lock - - - - -	6	1½?	18½	26	„
22. „ E. „ near Hunter's Mill, just below the Great Eastern Railway and the Reservoirs of the East London Water Company -	1¼	5½	20	26¾	„
23. Between Canal and River, Bromley Flood-gates - - -	4¼	12¾	7	24	„
24. „ „ „ Lock - - - -	14	—	12 (with clay)	26	„
25. Narrow Street, Limehouse - - - - - - -	12	—	18 (sand)		

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Geological Note by Mr. Whitaker.

(B.) *South of the Thames.*

(*a*) BORINGS along the line of the "OUTFALL SEWER, SOUTH SIDE."

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1. Same as No. 14, Bermondsey Branch, Low Level Sewer.					
2. Greenwich Junction of Romney Road and King Street - -	5	5½	15*	—	*Not bottomed.
3. Greenwich and Woolwich Lower Road, opp. Vicarage Lane -	1	—	23	24	Chalk.
4. " " " Coombe Farm Lane -	6	—	24½	30½	"
5. " " " Charlton Toll Bar -	5	—	—	5	"
6. Woolwich. Junction of Albion Road and Sand Street, S.W. corner of Dockyard - - - - - -	*	—	*	17	"
7. " " " Harden Street - -	2	—	—	2	12ft. of Thanet Sand, then Chalk.
8. North side of South-eastern Railway near eastern end of tunnel in rear of Edward Street - - - - - -	2	—	—	2	50 " " "
9. Northern side Beresford Square, end of Beresford Street - -	3¼	—	—	3¼	47 " " "
10. Plumstead Road, a little before it crosses the Railway - -	1	—	—	1	48 " " "
11. 12. In Plumstead Marsh, just beyond the limit of the 6-inch Ordnance Map, show 14 to 18 feet of alluvium underlaid by a thick bed of gravel.					
13. The borings at the Crossness Works are of the same kind.					

(*b.*) BORINGS along the Line of the "LOW LEVEL SEWER, SOUTH SIDE," MAIN LINE.

——	Made Ground and Soil.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1. Putney. In Wandsworth Lane, a little E. of Brewhouse Lane	$2\frac{1}{2}$	—	$23\frac{1}{2}$*	—	* Not bottomed.
2. Wandsworth. In Wandsworth Lane, just E. of the South-western Railway	—	—	$15\frac{1}{2}$	$15\frac{1}{2}$	London Clay.
3. " High Street, half way between Love Lane and Ram Lane	$4\frac{1}{2}$	—	$7\frac{1}{2}$	12	"
4. " Junction of York Road and North Street	—	6	17	23	"
5. " " " Jews Row	$1\frac{1}{2}$	—	15*	—	* Not bottomed.
6. York Road, Battersea Creek	$3\frac{1}{4}$	—	$21\frac{3}{4}$	25	London Clay.
7, 8, 9, 10, along Battersea Road, in Gravel, &c., from 15 to 25 feet		Not bottomed.			
11. London Gasworks, Nine Elms	12*	—	38	50	Clay touched. * Including what seems to be alluvium.
12. Wandsworth Road, Junction of, and Nine Elms	3	—	17*	—	* Not bottomed.
13. Kennington Oval (Harleyford Street)	$1\frac{1}{2}$	—	$22\frac{1}{4}$	$23\frac{3}{4}$	London Clay.
14. James Street, Camberwell New Road, (just N. of junction with Vassal Road)	$1\frac{3}{4}$	$1\frac{1}{2}$	6	$9\frac{1}{4}$	"
15. Camberwell Road, Grosvenor Street	1	$4\frac{1}{2}$	$16\frac{1}{2}$	22	Sandy Clay.
16. Neate Street, John Street	$1\frac{1}{2}$	$2\frac{1}{2}$	14	18	Sand, &c. of Woolwick Beds.
17. " just W. of Trafalgar Road	5	—	—	14	
18. Old Kent Road, close to Grand Surrey Canal	7 underlaid by $27\frac{1}{2}$ feet of Sands.				
19. " Shenton Street	3	—	29*	—	* Not bottomed.
20. " White Post Lane	$1\frac{1}{2}$	5	$24\frac{1}{2}$*	—	* Not bottomed.
21. " Cold Blow Lane	$2\frac{1}{2}$	—	$21\frac{1}{4}$	$23\frac{3}{4}$	Thanet Sand (10 feet) then Chalk
22. Cold Blow Lane, a little northward of the above	—	7	16	23	Chalk.
23. New Cross, Clifton Road, just S. of Edward Street	—	—	$32\frac{1}{2}$*	—	* Not bottomed.

Borings along the Line of the "Low Level Sewer, South Side," Bermondsey Branch.

——	Made Ground and Soil.	Alluvium.	Brick Earth.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1. Spa Road, near St. James' Church - - -	2 underlaid by 40 feet of sand and gravel, with a little clay ; then clay.					
2. Blue Anchor Lane, half-way between Bermondsey Low Road and the South-eastern Railway - - -	$3\frac{1}{4}$	—	?$3\frac{3}{4}$	$9\frac{1}{2}$	—	Not bottomed.
3. In Cork's Orchard - - - - -	$2\frac{1}{2}$	—	$5\frac{1}{2}$	18	26	Sand and clay, 27 feet.
4. Jamaica Level - - - - - -	4	4?	—	15	—	Not bottomed.
5. In Cart Road, leading to Gomm Road - - -	2	—	5	13	20	Sand, with a little clay ; 35 feet.
6. Deptford Lower Road, at China Hall Toll Gate - -	$1\frac{1}{2}$	?$16\frac{1}{2}$	—	19	37	Sand ; 15 feet.
7. " " 260 feet north-west of the Thames Junction Railway - - - - -	2	3	—	17 (sand)	—	
8. Deptford Lower Road, Black Horse Bridge (Grand Surrey Canal) - - - - - -	5	—	4	11	—	Not bottomed.
9. Evelyn Street, 350 feet from Black Horse Bridge -	5	—	—	$19\frac{1}{2}$	$24\frac{1}{2}$	7 feet sand (Thanet) then Chalk.
10. " High Street - - - -	$5\frac{1}{2}$	—	—	$36\frac{1}{2}$	—	Not bottomed.
11. Deptford, " Giffin Street - -	$7\frac{1}{2}$	—	—	$35\frac{1}{2}$	—	"
12. " Flood Street, in rear of houses at east side of street, and a little south of the Greenwich Railway.	5	—	4	24	33	Sand ; 14 feet.
13. " Creek, Gasworks - - - -	13		—	$20\frac{1}{2}$	—	
14. " " in Williams' Tan Yard - - -	$1\frac{1}{2}$	$7\frac{3}{4}$	—	$17\frac{3}{4}$	27	Sand (of Lower London Tertiaries) 26 feet.

APPENDIX.

On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Geological Note by Mr. Whitaker.

(*c.*) BORINGS along the Line of the "HIGH LEVEL SEWER, SOUTH SIDE."

——	Made Ground and Soil.	Alluvium.	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
MAIN LINE.					
1. Deptford Broadway, Church Street - - - - -	3	9½		—	——
2. New Cross, Mr. Trowel's farm, S. of Queen's Road - -	6	—	—	3	Clays and sands of Woolwich Beds.
3. Peckham, Eastwood's brickyard, W. of St. Mary's Church - -	2½	—	—	7	,, ,,
4. ,, Denham Road, just W. of Lyndhurst Road - -	3	2	2	2½	,, ,,
5. Camberwell, Crespigny Park, E. of Denmark Hill - - -	2	13½	10¾	26¼	London Clay.
6. ,, near N.W. corner of Lilford Road - - -	—	—	29	—	——
7. West corner of Stockwell Green - - - - - -	2½	—	10	12½	London Clay.
8. Stockwell, private road, junction of New Street and Bedford Row, just E. of Clapham Rise.	½	—	—	½	,,
9. "The Plough," Eastern corner of Clapham Common - -	2½	—	9½	12	——
EFFRA BRANCH.					
10. Cemetery Road, about S.S.E. of St. Mary's Church, Peckham -	3	—	—	3	Clays and sands of Woolwich Beds.
11. Southern end of Nunhead Green - - - - -	2½	—	—	2½	London Clay (thin); then sand and clay of Woolwich Beds.
12. Peckham Rye Road, where joined by the East Dulwich Road -	1	—	—	1	Clay and sand of Woolwich Beds.
13. Lordships Lane, nearly a quarter of a mile S. of Goose Green -	2½	—	—	2½	,, ,,
14. 15. } Five Fields, Dulwich (S. and W. ends of), 12 or 15 feet of London Clay over Woolwich Beds.					
16. Dulwich, fork of the roads - - - - - -	2	—	—	2	Clays of the Woolwich Beds.
17. ,, Common, Croxted Lane - - - - -	1	—	—	1	London Clay.

(*d.*) BORINGS along the "THAMES EMBANKMENT, SOUTH SIDE."

——	Made Ground and Soil.	Brick Earth (Loam).	Gravel and Sand.	Total Depth of Superficial Deposits.	Beds below.
1 to 6 are in the bed of the river.					
7. Lambeth, Lower Fore Street, east end of Doulton's Pottery - -	$3\frac{1}{2}$	—	$18\frac{1}{2}$	22	London Clay.
8. ,, N. of Fore Street, from east end of Stiff's Pottery - -	12	—	$19\frac{1}{2}$	$31\frac{1}{2}$	,,
9. ,, York Wharf - - - - - -	7	—	$17\frac{3}{4}$	$24\frac{3}{4}$	,,
10. ,, White Bear Alley, Upper Fore Street - - -	5	$3\frac{3}{4}$	18	$26\frac{3}{4}$	,,
11. ,, Upper Fore Street, close to White Gun Alley - -	$5\frac{1}{2}$	—	$19\frac{1}{2}$	25	,,

APPENDIX.

No. 7.
On the various Outbreaks of Cholera.

f. In London, by Mr. Radcliffe.

Note by Medical Officer.

[It is in many ways a question of vast public importance, whether last year's terrible outbreak of cholera in the eastern districts of London was produced by the distribution of infected water from certain reservoirs of the East London Water Company. Mr. Radcliffe's very elaborate and impartial inquiry has led him to the conclusion that it was so: and the *form* of his conclusion (a form which may have to be distinguished from the *substance*) is, that the water of the reservoirs, considered as drinking-water, had in it a power of direct infectiveness for those who drank it.

After giving my most careful judgment to the case, I feel bound to say that the facts adduced by him seem to me, as a whole, almost irresistibly to force the substance of his conclusion on the mind; but some of the exceptional cases to which he adverts in pages 312–325 of his report are apparently strong facts to the contrary. And having regard to the extreme gravity of the charge which is made against the water company, I feel it right distinctly to admit that I do not at present see my way to explain the apparent contradictions. It may be that the real explanation lies, even for all these cases, in conditions like those to which Mr. Radcliffe adverts in the important statement (printed in italics) at pages 324–5; in which event of course they would not in any degree contradict Mr. Radcliffe's general conclusion: but I confess I do not see how that sort of explanation is likely to cover the very striking immunity of the Limehouse school.

I need hardly say that I have with much care considered the whole matter of the East London epidemic in the light of Professor v. Pettenkofer's doctrine as to the laws of cholera epidemics. And the study of the matter in that point of view does, no doubt, show some facts which Pettenkofer would deem extremely significant. In the first place, in searching for conditions which might explain the special severity of cholera in those eastern districts of London, we come on the fact that, up to the end of 1865, in the affected territory, as far eastward as the river Lea, the construction of the main low-level sewer of the metropolitan drainage had, for a year or two, been constantly in progress with such more or less pumping of water from the sub-soil as had been necessary for the protection of the works; and that afterwards, for the six months immediately before the outbreak, the Isle of Dogs branch of this sewer (shown in Mr. Radcliffe's map as a red line running from Blackwall to Bromley) had been in progress, and had been *attended with a continuous*, but not very large, *removal of water from the gravel subsoil.** Now, in Pettenkofer's doctrine, the moment when ground-water is sinking in porous soil is the moment when a district is most disposed to choleraic infection; and it will be evident that the pumping which was and had been in progress in the parts referred to must have tended (I cannot say how much, nor over how wide an area) to bring the ground there, in the summer of 1866, into that "zeitliche Predisposition" for cholera. This fact, however, loses much of its significance when it is noticed that in the districts east of the Lea, where cholera began with even greater severity than in the last-mentioned districts, no such influence had been in operation:—indeed, I am assured by Mr. Rawlinson (whose evidence I must deem quite conclusive) that, for the last six or seven years, the permanent pumping arrangements connected with the sewerage east of the Lea have, to his knowledge, been such that no considerable oscillations in the water-level of the sub-soil have been possible. The second fact which I have to mention belongs to the exceptional case of the Limehouse school, and seems to illustrate Pettenkofer's doctrine of local immunities. For, in searching for the

* See next page.

conditions of the immunity of that school amid the general sufferings of its district, the only exceptional condition we could find is one of a geological sort: *the school stands as it were on an island of brick-earth, while all the immediately surrounding district is of gravel.*† There was another very interesting case, that of the City of London workhouse, where the "caprice" to be explained consisted in the choleraic affection of a small part of an otherwise unaffected large establishment; and our geological map (which represents the workhouse in question as standing on two different soils) suggested that in this curious little epidemic the parts of the building had been visited or not visited by cholera accordingly as they stood on the one soil or the other; but it will have been seen in Mr. Radcliffe's report (p. 317) that the architect of the building, in answer to our very minute inquiries as to the local differences of the soil, gave us to understand that of the represented brick-earth none had been left beneath the building, and that nearly all the building (unaffected equally with affected parts) had its foundations on gravel. It is possible that some other apparently exceptional facts in the East London epidemic may be more or less plausibly explained from Pettenkofer's point of view:—in regard of Stamford Hill, for instance, the comparatively high-level may be said to count for something; and in regard of North Woolwich it can be urged that so very low a district, in immediate proximity to the river, may easily have

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* The following table, for which I am indebted to Mr. Cooper, of the Metropolitan Board of Works, gives the best means I can procure for estimating the quantity of water removed in this part of the undertaking:—

CONSTRUCTION of SEWERS, Isle of Dogs Branch of Low-Level Sewer, between Main Low-Level at Bromley Railway Station and East India Dock Road.

Situation of pumping station.	Dates when at work.	Number of Men pumping.	Probable effect.
		(4 in. pumps.)	
No. 1 Shaft on private ground near St. Leonards Road and Railway Station.	From Feby. 5th to May 26th, 1856.	2 men night and day.	Drawing clear and apparently good water from the gravel.
No. 2 Shaft St. Leonards Road.	Feby. 12th to May 19th.	2 men night and day.	Do.
No. 3 do. do. -	Feby. 19th to May 26th.	2 men night and day.	Do.
No. 4 do. do. -	Feby. 26th to July 7th.	2 men night and day.	Do.
No. 5 do. Brunswick Road.	April 2d to July 21st.	2 men night and day.	Do.
No. 6 do. do. -	April 2d to July 28th.	2 men night and day.	Do.
No. 7 do. do. -	April 21st to Aug. 4th.	2 men night and day.	Do.
No. 8 do. do. -	April 23d to July 7th.	2 men night and day.	Do.
No. 9 do. Robin Hood Lane East India Dock Road.	June 18th to Sept. 1st.	2 men night and day.	Do.

† It will be noticed in the geological cholera-map that the other parts of the district marked as brick-earth have a fair allotment of cholera-dots on them; but Mr. Radcliffe is informed that in those parts the brick earth has been very extensively removed to give material for successive buildings, and the exact effect of these removals, in relation to our present subject-matter, could not be ascertained without innumerable (practically impossible) house-to-house examinations of the ground.

had something exceptional in the state of its ground-water and soil;* but there is too little detailed information on these and similar parts of the case for me to venture on any judgment concerning them.

On the whole, I fear it must for the present remain doubtful whether the influences to which Pettenkofer assigns so much importance were really potent in the East London epidemic, either as predestining its general severity, or as permitting exceptional facts within its area. But I may observe that the acceptance of that belief would not imply an acquittal of the East London Water Company as regards the causation of the epidemic. For in his doctrine the predispositions of time and place count for nothing till the exciting cause of the epidemic comes to bear on them; and high level or low level, brick earth or gravel, rising ground-water or falling ground-water, would all have been matters of indifference to the East London population unless the specific germs of cholera-contagium had been scattered broadcast in the territory. How this terrible scattering of the germs of the disease took place is the question which Mr. Radcliffe's inquiry aimed at answering; and his answer in substance is that the East London Water Company did the mischief.

I have said that it may be necessary to distinguish between the substance and the form of Mr. Radcliffe's conclusion. In proportion as Pettenkofer's views may prove right, doubts will occur whether the morbific power of the Old Ford water in those eastern districts (granting it to have been in fault) must have depended on the water's being drunk. It may be urged that, if the drinking of that water was the essential condition of the outbreak, it is difficult to conceive how cholera should not have been carried indiscriminately wherever the water was drunk, difficult to conceive how differences of soil or altitude could vary the infectiveness of the water within the same continuous area of potation. But, for the substance of Mr. Radcliffe's conclusion, is it necessary to assume that the water was drunk? So far as a cholera patient coming into a district can infect the population in other ways than through their drinking-water, must it not equally be the case that a water, infected with cholera-contagium, universally distributed and splashed about and wetting and soaking within a predisposed district, is dangerous independently of its being drunk? Or is it possible that under some conditions a water may be able to infect a soil, and mediately a population, with cholera, and yet not necessarily at the same time be an immediate cause of cholera to those who drink it? Our knowledge of the cholera-contagium, and of its modes of operation on the human body, is far too imperfect for me to pretend to answer these questions with all the qualifications which would be necessary to make the answer applicable to the present discussion. The importance, however, of the distinction which I have drawn will, I think, be evident. For if Mr. Radcliffe's conclusion is to be sustained exactly in the form in which he has drawn it (*i.e.*, virtually considering "distribution" and "drinking" to be equivalent terms in the argument) then perhaps he may be fairly challenged to show, as a rule with no considerable true exceptions, that the Old Ford water-supply carried cholera wherever it was drunk; and an exception really determined by difference of soil would seem almost hopelessly unintelligible. But if the particular form of the conclusion be set aside, and the conclusion simply affirm that the distribution of the Old Ford water caused the East London outbreak of cholera, then, to whatever extent that distribution operated on and through the soil of the territory, so far Pettenkofer's doctrine may admit of more or less plausible application to explain the partialities of the outbreak.—J. S.]

* In two opposite points of view the fact claims to be noted, as possibly interesting, that North Woolwich, having no sewers, could not participate in any influence (good or bad) which the sewerage-system east of the Lea may be deemed to have exerted on the eastern moiety of the outbreak.

No. 8. REPORT by Dr. HENRY G. SUTTON, on the CLINICAL CHARACTERS of the CHOLERA of 1866, as studied in MISS SELLON'S East London Cholera Hospital.

Two hundred and fifty cases of Asiatic cholera were admitted into the cholera hospital, Commercial Street, Whitechapel: of this number 54 per cent. died; also 114 cases of diarrhœa were admitted. All the cases were under my care, assisted by Mr. Frederick Mackenzie, our skilful resident medical officer. There was only one death from diarrhœa. Owing to Miss Sellon's most excellent management of the hospital I was enabled to procure most accurate details of what passed in the wards. My custom was to dictate at the bedside an account of the patient's symptoms, which the sister in charge of the ward wrote down on the patient's letter; this was done usually three or four times a day. The sisters soon learned to recognize the different symptoms of the disease, and their education, talent, and well-trained minds proved of the greatest assistance to me in collecting these records of the cases.

In this paper I have endeavoured to give an analysis of the notes of the cases, feeling convinced that it is my duty to record facts rather than to express opinions. I regret that space prevents me recording many more interesting and very instructive cases; the records, however, can be consulted by anyone desirous of further studying the cases.

No case was considered to be cholera unless I saw the characteristic rice-water evacuations, and this was the broad line I drew betwixt the cases of so-called choleraic diarrhœa and those of cholera. A few cases were admitted in reaction. Generally it was not difficult to recognize the stage of consecutive fever, and by the history to determine that it was a case of cholera. In a few instances it was, however, exceedingly difficult in the beginning to say whether the typhoid symptoms were due to cholera or to typhoid fever; when the patient had been in the hospital a few days the difficulty cleared up.

Premonitory Diarrhœa.—It was difficult to decide as to what number of patients had had premonitory diarrhœa. This was mainly owing to two circumstances—the difficulty of obtaining an accurate history of the early symptoms; next, of deciding where the diarrhœa ended and the true cholera process began. Without entering into the discussion as to what relation premonitory diarrhœa bears to cholera, I would simply mention that I have endeavoured to draw such a line as would place all the undoubted cases of premonitory diarrhœa on one side, and all the doubtful cases, and those in which there was no such diarrhœa, on the other side.

By this means I was enabled to see what proportion of the cases had had undoubted premonitory diarrhœa.

In order to do this I have arranged the cases as follows, viz.:—

Where purging commenced 24 hours, or two, three, or four days, before the violent symptoms, such as vomiting, purging, and cramps, set in, such patients I have considered to have had premonitory diarrhœa.

Where the purging came on only a few hours before the violent symptoms; such cases I have considered to have had no decided premonitory diarrhœa. For it could not, generally speaking, be deemed "premonitory" in the most important practical sense—the sense of giving good opportunities for treatment; and therefore I do not speak of such cases as having had premonitory diarrhœa; and there were cases in which the severe symptoms began quite suddenly. It was not uncommon to hear that a patient was quite well at dinner time, in the evening was seized with severe vomiting, purging, and cramps,

APPENDIX.

No. 8.
On the Clinical Characters of Cholera, 1866, *by Dr. Sutton.*

and on admission into the hospital was found to be in collapse. Or a man had returned from his work apparently well, later in the evening did not feel quite well, in the middle of the night was seized with well-marked symptoms of cholera. Cases such as I have just named were admitted into the hospital a few hours after the commencement of the attack, and found to be in a state of collapse. In these cases there was no evidence of premonitory diarrhœa. Where a patient was taken ill at 8 p.m., Oct. 3rd, and quite well before that hour, with purging and vomiting, and admitted into the hospital Oct. 4th, at 7 p.m., in a state of collapse, I have concluded that there was no evidence of premonitory diarrhœa. Again, when the vomiting, purging, and cramps in legs commenced for the first time one day, and on the day following the patient was admitted into the Hospital in reaction, I have concluded there had been no premonitory diarrhœa. In order to make these remarks still more clear, I would observe it was common to hear a patient state that he was relaxed in his bowels yesterday, that he got better towards night, and went to bed pretty comfortable, and in the middle of the night or very early next morning he was seized with purging, vomiting, followed by cramps in the legs. As I have just said, that was a very common history of the way the attack came on. Such patients I have considered to have had premonitory diarrhœa during one day. In a few cases the diarrhœa preceded the true cholera symptoms several days, or even weeks, as the following statistics will show:—

In four cases, the diarrhœa had preceded the cholera symptoms by some weeks. One patient had had diarrhœa eight weeks, one five weeks, and two two weeks before the symptoms of cholera set in.

It may be interesting and even instructive to record a few particulars of the cases that had diarrhœa for some weeks before the violent symptoms of cholera set in.

One patient stated he had had diarrhœa for six weeks before his admission into the hospital. His wife confirmed his statement; the Chaplain of the Hospital had been in the habit of seeing the patient, and he stated to me that during the six weeks previous to patient's admission he had several times heard him complain of diarrhœa. The patient he was suddenly seized in the morning of the day of admission with symptoms of cholera, and on admission he was in decided collapse. He died within three days after his admission. His wife washed the clothes belonging to the hospital, and it was thought possible that he might have caught cholera in consequence.

Another case, a female patient, was in the hospital for some days with all the symptoms of ordinary diarrhœa, her evacuations were watery and fæcal. She improved very much, and the diarrhœa had almost entirely disappeared, and it was proposed to discharge her. I saw the patient one afternoon and she appeared to be doing well; I saw her again in the evening of the same day, and I heard that she had been seized with very violent vomiting and purging, and a few hours afterwards, after the vomiting, purging, and cramps, she passed into a state of collapse, and died early next morning.

A third case was that of a man who was in the Cholera Hospital about two weeks for simple diarrhœa; he quite recovered from it, and was able to go about the wards apparently quite convalescent. He was recommended for the Ascot convalescent hospital. Soon after he got there, in about 48 hours, he was seized with cholera and died.

Of 127 cases, in 80 there was no decided premonitory diarrhœa, merely relaxation of the bowels, which commenced a few hours, that is, something less than 12 hours, before the alarming symptoms—violent vomiting, purging, and cramps—set in.

In 41 there was evidence to show decided premonitory diarrhœa, the duration of which varied from 12 hours to four or five weeks.

It was doubtful in five cases whether there had been any such diarrhœa; in one no history could be obtained.

Of the 41 examples in which there was undoubted premonitory diarrhœa, the duration of the latter was as follows:—

In	3 cases - - -	12 hours.
,,	1 ,, - - - -	18 ,,
,,	1 ,, - - - -	19 ,,
,,	7 ,, - - - -	1 day.
,,	1 ,, - - - -	1 day 9 hours.
,,	12 ,, - - - -	2 days.
,,	6 ,, - - - -	3 ,,
,,	2 ,, - - - -	4 ,,
,,	2 ,, - - - -	5 ,,
,,	1 ,, - - - -	6 ,,
,,	1 ,, - - - -	7 ,,
,,	2 ,, - - - -	2 weeks.
,,	1 ,, - - - -	5 ,,
,,	1 ,, - - - -	8 ,,

,, 1 ,, a history of premonitory diarrhœa of some days duration, the number not given.

On referring to the above figures, it may be observed that in more than half the number of cases the diarrhœa preceded the marked symptoms by one, two, or three days. Of the 41 cases, in 26 the diarrhœa was limited to the first three days.

The hours when patients are most frequently seized with cholera.

The experience of Briquet and Mignot confirms this observation (vide Dr. Gull's report on cholera to the Royal College of Physicians, page 128). "In 143 cases the symptoms were constantly preceded by "diarrhœa more or less severe; of that number no less than 70 occurred "during the first three days."

To consider that a diarrhœa going on two, five, or eight weeks is part of the cholera attack, would be in opposition to all we know of the premonitory symptoms of other diseases.

The catarrhal symptoms of measles, the pain in back, head, and vomiting of small pox, are all limited to a few days. Where there was diarrhœa, therefore, of two, four, and eight weeks standing, such ought in accordance with analogy to be considered as cases in which there had been simple diarrhœa, and on the latter cholera had been grafted.

Experience has shown, and it has been many times recorded, that the symptoms of cholera more frequently come on during the night than during the daytime. The evidence contained in the following table confirms such experience. The table shows that of 150 cases, in 60 the severe symptoms set in during the daytime, and in 90 during the night. In the table the daytime has been arranged from 8 o'clock in the morning to 8 o'clock in the evening; the night time from 8 o'clock in the evening to 8 o'clock next morning. It is an artificial division, but it is one that has its advantages. It embraces as many as possible of the hours that belong to day, and the same with reference to hours that belong to night time.

23 males and 37 females were attacked during the day, 41 males and 49 females were attacked during the night. More females than males were attacked during the night, for the simple reason, in the 150 cases there was a greater proportion of females than males.

More persons were seized from 12 o'clock at midnight to 3 o'clock in the morning than at any other time; during these hours 31 persons

were attacked, whereas in the corresponding hours of the daytime only 17 persons were attacked.

The smallest number of persons were attacked between the hours of 11 and 12 in the forenoon and 4 and 5 in the afternoon.

From 3 to 5 o'clock proportionately few persons were attacked. From 3 to 5 o'clock in the morning 10 persons were attacked; from 3 to 5 o'clock in the afternoon 8 persons were attacked. Between the hours of 10 and 12 in the day 10 persons, and between 10 and 12 in the night 10 persons, were seized. Between 9 and 12 in the day-time 15 persons were seized; between 9 and 12 in the night time 14 persons were attacked.

From 6 o'clock to 9 o'clock a proportionately large number of persons were struck down, this was the case both morning and evening. From 6 to 9 in the morning 16 persons, from 6 to 9 in the evening 26 persons, making in all 42 cases. This was the largest number in any three corresponding hours of either the day or night, except from 12 to 3 o'clock. In the daytime during the last-named hours 17 persons, in night time 31 persons, making in all 48 persons who were attacked betwixt the hours of 12 and 3 o'clock. The number of persons taken ill during the hours of 12 and 3 is large, because of the large number seized from 12 at midnight and 3 in the morning.

No. 1.

A Table showing the Hours when Patients were seized with Cholera, when undoubted Cholera Symptoms set in, also the Number of Cases arranged under different Hours.

Males.

The hours at which patients were seized—when undoubted symptoms set in.	8–9	9–10	10–11	11–12	12–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8
Day time. The number of cases - -	2	3	3	—	4	—	4	—	1	3	2	1
Night time. The number of cases - -	4	3	2	—	7	5	4	2	2	4	6	2

Females.

Daytime. The number of cases - -	6	2	5	2	2	2	5	2	5	1	2	3
Night time. The number of cases - -	2	1	6	2	4	7	4	5	1	5	5	7
Total number attacked during day time under the head of different hours - -	8	5	8	2	6	2	9	2	6	4	4	4

FEMALES—*cont.*

The hours at which patients were seized—when undoubted symptoms set in.	8–9	9–10	10–11	11–12	12–1	1–2	2–3	3–4	4-5	5–6	6–7	7–8
Total number attacked during night time under the head of different hours -	6	4	8	2	11	12	8	7	3	9	11	9
Total number attacked during day and night under the head of different hours - -	14	9	16	4	17	14	17	9	9	13	15	13

The above table, therefore, shows that persons are most liable to be seized with cholera between the hours of 6 and 9 in the morning and evening, and 12 and 3 at midnight.

I propose now to examine at what hours of the day or night the patients died of cholera, and to endeavour to ascertain if they died more frequently at one part than at another part of the day.

The hours when patients most frequently died.

It will be seen on examining the table given below that I have grouped the number of deaths under separate hours, and divided the 24 hours into day and night time. I have adopted the same artificial division of the day as in the preceding table, calculating the day from eight o'clock in the morning to eight o'clock at night, and the same with respect to the night. I have separated the males from the females, in order to ascertain if the same law holds good with both sexes.

The largest number of deaths took place betwixt the hours of 7 and 11 in the morning and 7 and 11 in the evening. This was the case both with respect to the males and to the females. The following is an analysis of this table. The day is divided into three parts, the night the same, and each part is made up of four hours. The number of deaths that occurred during those hours are thus given, and we are able at a glance to see at what part of the day the patients most frequently died.

———	From the hours of 7–11.	From the hours of 11–3.	From the hours of 3–7.	Total number of Deaths.
Daytime.				
Males - - - -	12	6	6	24
Females - - - -	17	5	8	30
Total - -	29	11	14	54
Night time.				
Males - - - -	13	6	12	31
Females - - - -	15	11	7	33
Total - - -	28	17	19	64

This analysis shows that during the day from 7 to 11 o'clock, there were 29 deaths; from 11 o'clock to 3 o'clock 11 deaths took place; from 3 to 7 o'clock there were 14 deaths. During the night time, from 7 to

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11 o'clock, there were 28 deaths; from 11 to 3 o'clock, 17 deaths; and from 3 to 7 o'clock there were 19 deaths.

The total number of deaths that took place betwixt the hours of 7 and 11 in the morning and night was 57, whereas only 28 during the hours of 11 to 3, and 33 deaths from 3 until 7 o'clock. Almost as many deaths took place between the hours of 7 and 11 as in all the other hours of the day put together.

It is still more instructive to notice that the same thing held good with the males as well as the with females, which would tend to show that there is some cause acting on both sexes at those particular hours.

No. 2.

A TABLE showing the Hours when PATIENTS DIED.

MALES,

The Hours of the Day and Night in which the Patients died.	8–9	9–10	10–11	11–12	12–1	1–2	2–3	3–4	4–5	5–6	6–7	7–8
Daytime. The number of ses - -	4	4	3	1	2	2	1	2	2	0	2	1
Night time. The number of cases - -	2	5	3	4	0	2	0	2	4	5	1	3

FEMALES.

Daytime. The number of cases - -	3	5	4	1	1	1	2	2	3	3	0	5
Night time. The number of cases - -	1	5	3	0	4	4	3	2	0	3	2	6
Total number of deaths during day time under the head of different hours - -	7	9	7	2	3	3	3	4	5	3	2	6
Total number of deaths during night time under the head of different hours - -	3	10	6	4	4	6	3	4	4	8	3	9
Total number of deaths during day and night nnder the head of different hours - -	10	19	13	6	7	9	6	8	9	11	5	15

These particulars, showing the hours when persons were attacked with and died of cholera, are not without interest. The number of cases are too few to establish any general law as to the exact hours when patients may be expected to be seized or die of that disease; yet they are enough to show that persons are more likely to be attacked and die during some than other hours of day. These might be considered as the critical hours, and a true knowledge of such times would be of the utmost importance in the treatment of and especially of the expectant treatment of disease. The aim of expectant medicine is not simply to stand by and do nothing, but it is to watch the disease, to see if it is running its "natural" course—to judge whether the patient tends to do well, and if not, to ascertain how he tends to die, and to strive to counteract such tendency, and thus to gain time. It is very important, therefore, to know the hours when the vital powers are likely to be very feeble and vital functions almost brought to a stop; we may then assist the struggling patient at these particular times; and, as in the words of Professor Laycock (*vide* Medical Observations and Research, page 117,) after stating that many diseases manifest a law of periodicity, he goes on to say—"The various exacerbations, remissions, and phases may be therefore anticipated and provided against, or if remedies be given, the action of the remedies may be considered apart from the action of the law of sequence."

Note by Medical Officer.

[The average distribution of Dr. Sutton's 118 deaths through 24 hours of day and night would give a rate of about 5 deaths for each hour. From this average rate the most important deviation seemed to be in the four morning hours, 7–11, when the rate was 7½ per hour. An excess of less marked degree appeared also in the four corresponding evening hours, when the rate was 6¼, and in the last two of those hours, 8. Of course Dr. Sutton's numbers are too few, greatly too few, to justify any general conclusions; and it may therefore be convenient to refer to the facts on this question which were collected at Leipzig in the late epidemic. Dr. Schmieder, in his lately published statistics of that visitation, gives the hours of death of 1,278 cases; and it is noticeable that his hours of least mortality were just those forenoon hours when the Whitechapel deaths were most numerous. In Leipzig the number of deaths per hour, if the total had been uniformly distributed, would have been 53¼; but in fact the hourly distribution of deaths in the four successive quarters of the day, counting from midnight, averaged about as follows: during the first quarter, 51; during the second quarter (which on the Whitechapel analogy ought to have been highest) 46; during the third quarter, 60; during the fourth quarter, 56. Evidently nothing as to the natural history of cholera can be inferred from facts of this sort, unless they be accumulated in very large numbers; nor, unless also the reader be tolerably acquainted with the *horaria* (as to nursing, &c.) of the hospitals whence the facts have been reported. In any future registration of such facts it would be desirable to make separate enumeration of deaths in collapse, as distinguished from deaths in reaction and fever. Of course, too, in discussing the subject of hour of death, regard must be had to the hour of so-called "attack," *i.e.*, the hour of manifestation of severe symptoms. And if this should seem to be governed, at least locally, by some general law, the determining influence of local modes of life would need consideration.—J.S.]

The manner in which the attacks commenced.

I have already mentioned, when speaking of premonitory diarrhœa, the patients commonly stated that they had had diarrhœa, or that they were purged more or less, a little before the violent symptoms of the true cholera process began; therefore it is only necessary here to say that after a longer or shorter duration of a few hours or a few days, of

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simple diarrhœa the symptoms became greatly aggravated, the vomiting and purging first, and soon afterwards the cramps in the calves of the legs set in. Generally the cramps came on about an hour or two after the vomiting and purging; in some, however, the interval was longer, in others shorter.

Prodromata.

In a very few cases there was a history of symptoms preceding the vomiting and purging. I venture to give the following record of such a case :—

Elizabeth B., aged 17; residence, Bethnal Green, a machinist. She was admitted into the Cholera Hospital Sept. 26th at 8.30 a.m. Her symptoms first set in Sept. 25th at 11 p.m. Her mother stated that she had always been a delicate girl. She appeared quite well until 11 p.m. Sept. 25th, the evening before admission. At 11 o'clock she turned faint. Her mother gave her port wine and arrowroot; she then fell asleep. At 3 a.m. next morning—that is, Sept. 26—she was woke up with purging, and she began to vomit. She was purged four or five times. A dose of diarrhœa medicine was given. The stool was said to have been like " the white of an unboiled egg." The vomited matter was also white, with pieces of undigested food. At 8.30 a.m. Sept. 26—that is, half an hour after she was admitted, and nine hours after the attack set in, she was pulseless, respiration 40, tongue cold, colour exceedingly livid, eyes semi-closed, moans feebly at intervals.

9 a.m. She is less livid, face more natural, skin is less damp and feels warmer, complains of pain in her back.

10 a.m. Has again become much more livid, restless, trying to be sick, with expression of great distress.

10.30. a.m. Breathing more laboured, respiration irregular and gasping, she is evidently sinking fast, and she died 11.30. a.m., September 26th, that is, $12\frac{1}{2}$ hours after the commencement of the attack.

The symptoms of the cholera process set in very suddenly in some cases.

The cholera process in in some patients set very suddenly, with vomiting and purging without any previous warning, and at a time when the patients appeared to be in their usual health, as the three examples will show.

Emma S., aged 41, residence Spitalfields, a widow, admitted into the Cholera Hospital September 13th, at 2.15 p.m. Date and hour of attack September 13th, at 9 a.m. She was going out to work and was taken suddenly ill in the street with cramps in her legs, and purging at 9 a.m., and she vomited some tea that she had drank. She was purged frequently, watery evacuations, colour unknown. On admission $5\frac{1}{2}$ hours after the commencement of the attack her tongue was quite cold and white, eyes sunken, lips livid, hands livid, sodden, and cold; with great care her pulse could be felt at the wrist, but she was virtually pulseless. 3·30 p.m., purged, evacuation rice water, flaky; respiration 52. She died September 14, 5 a.m.

Cases in which there was no premonitory diarrhœa.

The following is another very instructive case of this kind.

Ellen Proctor, aged 26. Her mother stated that she saw her at 9 a.m. September 25th, and she was then quite well; at 10 a.m. September 25th, that is, an hour later in the same morning, she was taken suddenly ill with vomiting and purging, and very violently so, at the place where she was working in Hoxton. At 3 p.m. she walked back to her mother's house, and her mother was struck with her appearance. She was livid, cold, and clammy. She vomited, also was purged frequently. This ceased after she had taken some medicine about 6 p.m. She was afterwards taken much worse with cramps in her legs. She was admitted into the Cholera Hospital at 1 o'clock at midnight September 26th—that is, 16 hours after her symptoms set in—in a dying state. She was livid,

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pulseless, speechless, skin cold, tongue cold, unable to swallow, choleraic aspect. She died 15 minutes after admission.

There was no premonitory diarrhœa in the cases just recorded, and the algide symptoms were very severe and set in rapidly; and my experience would lead me to think that the absence of premonitory diarrhœa, the sudden onset of the cholera process, the severity of the collapse, and the fatal character of the disease, are events frequently associated, and very often go together, but not invariably so. It does not follow because a patient has had premonitory diarrhœa that the algide symptoms may not be intensely marked, and that quite as much so as in other cases where there has been no such diarrhœa.

In confirmation of this we would briefly mention the following particulars:—

A patient was in the Cholera Hospital with symptoms of diarrhœa; after being in a few days he appeared to have recovered and was discharged. He left the hospital at 9 a.m., he was taken ill with vomiting and purging at 10 o'clock a.m. of the same day; he was admitted again into the hospital on the same morning as he was discharged, with well-marked symptoms of cholera. He died the same day.

Another case was that of a patient who had had diarrhœa off and on for two or three weeks; he was one morning early seized with severe vomiting, purging, and cramps in legs; about 10 a.m. that morning he was admitted into the Cholera Hospital with well-marked and severe algide symptoms. He lived long enough to enter into imperfect reaction, and then died.

A third example was that of a man who was in the Cholera Hospital about two week with diarrhœa, apparently ordinary diarrhœa. He improved and was thought to be convalescent, in consequence was discharged, and recommended for the Convalescent Hospital. About two days after he got released he was seized with severe cholera symptoms and died.

Is the cholera process limited in its duration?

Asiatic cholera is usually divided into two stages, the "cold stage" and the "hot" or consecutive fever or reaction stage. In the former are all the characteristic phenomena of cholera; the "cold stage" is always present more or less, whereas the hot stage may be absent; the latter is not an essential part of the disease; the hot stage varies very much, in the mild cases of cholera it is very short, and scarcely appreciable. In the severe cases it is long and protracted, at least in this country.

I propose here to inquire whether the so-called "cold stage" is limited to a definite time; or whether the vomiting, purging of rice-water, cramps, and algide symptoms common to this part of the disease go on hour by hour irregularly, irrespectively of any definite number of hours?

Observers have ascertained the number of hours patients remained in collapse, and found the time varied very much. The phenomena of collapse appear not to be limited to any definite time, and a little consideration will show that this is no more than what might have been expected. For some patients went into collapse at an early period of the attack, and remained in it for some hours. Others did not go into collapse until after the vomiting and purging had continued several hours, and in the latter class the collapse was often not protracted. In the milder cases the algide symptoms were scarcely or even not at all marked, and all experience has shown that the collapse of cholera is not always present.

In every case of cholera there are always present, with the exception of those rare cases which have been said to die without any

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purging, certain well-marked and characteristic symptoms, such as vomiting, purging, rice-water evacuations, cramps, &c., which make up the so-called cold stage. It has therefore appeared to me as likely to lead to a more satisfactory result, if I endeavoured to try and ascertain what period elapsed from the time when a patient was seized with these characteristic symptoms of the cold stage to the time of his entering reaction.

In order to do this it was necessary to decide what should be the starting point of the calculation, and what signs should indicate the commencement of reaction.

Almost all of the patients gave a history of a time, usually a certain hour, when their symptoms became greatly aggravated, or, as they termed, they were taken much worse. It was very common to hear a patient say that he was purged in the middle or some other part of the day, and taken much worse at a certain hour with violent purging, vomiting, and cramps in the middle of the night or early next morning, and he further said he had continued to get worse and worse until his admission. The hour when the violent symptoms set in I have considered as the starting point, or, in other words, the hour when the patient was seized.

It was next necessary to determine what should be considered as evidence that the patient was entering reaction, and the following are the particulars which have guided me. Where it was stated that a patient had been almost or even pulseless, with a cold tongue, livid, wakeful, and at a certain hour the pulse had again become distinct, and remained distinct, tongue warm and colour natural, the hour when the pulse, tongue, and colour improved, I have considered as the time when reaction commenced. Or if the patient had the well-marked symptoms of cholera,—passing rice-water or colourless evacuations, with a very small pulse or pulseless, and afterwards the evacuations became yellow, and like pea-soup, and the pulse again became more distinct; the hour at which the changes in the character of the evacuation and pulse appeared I have assumed to be the beginning of reaction. Again, when a patient who had been some hours in marked collapse had become warm, pulse distinct, colour natural, and slept for some hours; or the hour when a patient who had been in collapse had become flushed in face and his pulse distinct, I have regarded as the commencement of reaction.

In some cases, however, it was impossible to make any calculation, for the reaction was so imperfect, and many of the symptoms of collapse remained until death. The pulse became for an hour or two more distinct, and the colour became natural; but the pulse continued to be exceedingly feeble and scarcely to be felt; after being present a little while again disappeared; the hands became cold and livid, the patient wakeful. Such cases have I classed in the table given below, under the head of imperfect reaction. The patients continued in this state of imperfect reaction some hours, or for even days, and then died. Some cases have been arranged under the head of protracted and incomplete reaction—13 cases wer in undoubted reaction on admission. In 19 the records were imperfect, so that no calculation could be made In 19 cases death took place while the patients had all the signs of decided collapse. See Table No. 3, p. . In 61 cases I have been enabled to estimate the duration of the cold stage. Of this number the longest number of hours in this stage was 31, and the shortest 16 hours; there were two cases where this stage had been limited to 16 hours, one of which had bloody evacuations, and died; in one, this stage lasted only 18 hours; the majority ranged from 23 to 28 hours.

No. 3.

A TABLE showing the Duration of the so-called "COLD STAGE."

Number of Persons who died in Collapsis, and the Number of Hours after seizure that Death took place.	The Number of Persons in Reaction on admission, and how many hours after seizure.	The Number in which the Report does not permit of a calculation.	The Number who died in imperfect Reaction.	Number who died in protracted incomplete Reaction.	The Duration of the stage preceding Reaction, and Number of Cases.		Number of Hours before complete Reaction.
1. 1 person died 13 hours after seizure. 2. 1 ditto 13 ditto. 3. 1 ditto 12 ditto. 4. 1 ditto 16 ditto. 5. 1 ditto 17 ditto. 6. 1 ditto 20 ditto. 7. 1 ditto 18 ditto. 8. 1 ditto 10 ditto. 9. 1 ditto 10½ ditto. 10. 1 ditto 19 ditto. 11. 1 ditto 16 ditto. 12. 1 ditto 9½ ditto. 13. 1 ditto 14 hours and 50 minutes ditto. 14. 1 ditto 9 hours ditto. 15. 1 ditto 14 ditto. 16. 1 ditto 20 ditto. 17. 1 ditto 20 hours and 15 minutes ditto. 18. 1 ditto 9 hours ditto. 19. 1 ditto 24 ditto.	13 in all. Amongst this number were— 1 26 hours after seizure. 1 2 days ditto. 1 36 hours ditto. 1 30 hours ditto. 1 2 days 9 hours ditto. 1 4 days ditto.	19.	14. Of this number— 1 died 13 hours after seizure with bloody evacuations. 1 28 hours after seizure. 1 30 hours ditto.	8. Of this number it was in— 1 case 40 hours. 1 3 days. 1 32 hours, bloody evacuation.	Hours. 1. 24 2. 26 3. 29 4. 28 5. 23 6. 25 7. 25 8. 21 9. 24 10. 26 11. 30 12. 29 13. 26 14. 25 15. 18½ 16. 26 17. 28 18. 30 19. 24 20. 27 21. 28 22. 29 23. 25½ 24. 29 25. 23 26. 22 bloody evacuation. 27. 26½ 28. 24 29. 16 bloody evacuation. 30. 24 31. 29 32. 31	Hours. 33. 26 34. 23 bloody evacuation. 35. 25 36. 26 37. 24 38. 30 39. 28½ 40. 29 41. 16 42. 27 43. 24 44. 31 45. 24 46. 24 47. 17 reaction commencing. 48. 25 49. 24 50. 26 bloody evacuation. 51. 28½ 52. 25 bloody evacuation. 53. 28 54. 28 difficult to calculate. 55. 24 56. 28 difficult to calculate. 57. 27 58. 21 59. 26 60. 28 61. 24	Hours. 1. 36 2. 35½ 3. 32 4. 33 5. 32 6. 36 7. 32 8. 30 9. 33

The average duration of this stage was 25 hours, and probably 24 hours would be more correct, for in those instances in which the symptoms set in suddenly, without any decided premonitory diarrhœa, where the collapse was great, and the reaction very decided, the duration of the "cold stage" was about 24 hours.

Making allowance for the difficulty of ascertaining the correct time when the patient was seized, and the difficulty of fixing upon the hour when reaction really commenced, sometime betwixt 20 and 30 hours was found to be the usual duration of the "cold stage."

There are three ways of testing the correctness of these conclusions as regards numbers of hours.

First, did any of those dying before the 24 hours, calculating from the time of seizure, show any signs of reaction? Were there any cases in reaction in 12, 16, or 18 hours after the characteristic symptoms had set in?

Secondly. Amongst those who were admitted in reaction, was there any evidence to show that this "cold stage" had been shorter than 24 hours?

Thirdly. Was there any evidence that a patient had continued to pass rice-water evacuations for any period longer than 24 hours or 30 hours?

With respect to the first question, the evidence was as follows: —Seventeen persons died in collapse, with well-marked algide symptoms. Of this number the shortest period from the time when characteristic symptoms set in to the time of death was nine hours, and the longest period was 24 hours. The average length of this period in these 17 cases was 15·1 hours. In not one of these 17 cases were there any signs of reaction.

Amongst the 61 cases classed under the head (*see* table, page 8) of duration of cold stage it may be noticed that there are three examples in which the period was respectively 16, 16, and 18½ hours, that is, all under 20 hours. One of these had bloody evacuations. One patient died in imperfect reaction 13 hours after seizure with bloody evacuations; and I shall have occasion further on to show that cases with bloody evacuations run a very irregular course.

When, however, it is borne in mind that out of 61 cases in only three was this the case, and at the same time remembering how difficult it is to ascertain accurately the precise hour when the violent symptoms set in, it will probably be allowed that such exceptions do not materially weaken the evidence in favour of the "cold stage" being limited for the most part to the time named above.

In answer to the second question, 13 persons were in decided reaction on admission, and in not one instance was there any evidence to show that the duration of the "cold stage" had been less than 24 hours. Of 14 persons who died after reaction had commenced, but before it was complete, in all, with the exception of one, a period of more than 24 hours had elapsed from the time that undoubted symptoms of cholera had set in.

In 19 cases the records would not permit of any calculation being made as to the duration of the "cold stage;" that was entirely owing to the imperfect manner in which the notes had been kept.

The reaction was imperfect in 22 patients: they all died; and of these every one showed some sign of reaction.

In nine cases there were no means of estimating when the patient entered the stage of reaction, but clear evidence to show that the patient was in undoubted reaction at a certain hour. The number of hours in these nine cases, dating from the commencement of characteristic symptoms, varied from 32 to 36.

From the above particulars it will probably be allowed that there are good reasons to think that the cholera process belonging to the "cold stage" runs a definite course; and that the difficulty in obtaining accurate information as to the precise hours the patients were seized will account for the disparity in the number of hours in the individual cases, but the average of the number may be taken as near the true period.

In a few mild cases there was vomiting and purging of "rice-water" looking fluid, yet so little that it was difficult to calculate the duration of the "cold stage." With cholera, as with typhoid fever, there is a class of case in which the symptoms are so feebly marked that it is next to impossible to say when the disease set in. In these mild cases of cholera the reaction appeared to commence much before 24 hours. It was impossible, however, to estimate accurately the duration of this stage.

Our experience in the post-mortem examinations of subjects who had died from cholera would induce us to be very cautious in arriving at a conclusion as to whether a patient has died in true collapse or in very imperfect reaction, and I should be fully prepared to find that some of those who were said to have died in collapse would on the post-mortem table have shown some signs of commencing reaction, especially bloody evacuations.

Some remarks on collapse.

The symptoms characteristic of the collapse stage during the late epidemic, according to what I saw in the Cholera Hospital and in the London Hospital, corresponded with those witnessed in other epidemics. The pulse was only just perceptible—that was with great care—or the patients were pulseless; the extremities were cold; the tongue was very cold, sodden, coated with thin white fur; marked lividity, especially in adults; old people and infants were, as a rule, less livid; the voice was reduced almost to a whisper; the eyes were sunken, pupils dilated, conjunctiva white and glassy; hands sodden and shrivelled; the patient restless, turning from side to side, with the eyes for the most part wide open, or closed only for a few moments at a time; very wakeful; excessive thirst, to such a degree that little children would get out of their beds and go and place their mouths under the water tap; cramps in the calves of the legs, extending up to the thighs and walls of the abdomen, in exceptional cases into the upper extremities. The patients manifested a great indifference as to their condition. When the patients were in extreme collapse the purging often ceased, and that in some cases for some hours.

The most fatal form of cholera.

In the worst cases of cholera the vomiting and purging began suddenly and violently, went on rapidly, the algide symptoms set in very early, and there was very little and often not any purging during collapse.

In the next table 25 cases are given, and in each case the period of time that elapsed from the hour when patients were seized with violent symptoms to the hour when patients were admitted into the hospital in collapse is given; the mean duration was $8\frac{1}{2}$ hours. The shortest period was 1 hour 45 minutes; the longest was 13 hours.

I would here record some particulars of two cases in order to show how patients may have very little purging while in the hospital, have very little vomiting, and at the same time they may be in severe collapse.

Cases to show the purging very much.

Mary Nicholls, aged 39. She was admitted into the Cholera Hospital, August 26th, at 12 at noon, under the care of Dr. H. G. Sutton. Her history was as follows:—Having been quite well the day before, she was taken suddenly ill at 6 a.m., August 26th. She had been very much purged since 6 a.m., and she had vomited twice. On admission into the hospital her pulse was found to be exceedingly feeble, tongue cold, eyes sunken. The typical choleraic aspect; the choleraic voice. She was

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markedly livid. Fingers shrivelled. Cramps in her legs. Temperature in the axilla was $92\frac{1}{5}$. At 1 o'clock, that is, one hour after admission, she was pulseless, very livid. She had one dose of castor oil, two drachms; had been purged once, rice-water looking fluid.

5.30 p.m. She feels a little better, respiration 40, and she complains that her mouth feels "so bad;" markedly livid, cramps severe; tongue cold. She has had five doses in all of the oil, that is, 10 drachms, and no evacuation since the oil was administered. Pulse can be felt, but it is exceedingly feeble.

8.30 p.m. She is pulseless, tongue cold, hands shrivelled and livid, bowels relieved once. Her voice is exceedingly feeble, and she is apparently dying.

1.45 midnight. Almost insensible; she is weaker and is livid; no purging, no vomiting. She died August 27th, 7.15 a.m.

Notwithstanding that this patient was in the hospital $19\frac{1}{4}$ hours, and taken 10 drachms of castor oil, she was only purged once; during that time she was in deep collapse; it is further to be noticed that six hours after the violent symptoms set in the patient was in collapse.

A female was seized with cholera on the morning of her admission into the hospital. Sept. 1st, at 10 a.m., she got rapidly worse, and thought she was "going to die;" she vomited and was purged very much that morning. She was purged, and she vomited several times soon after admission. Her eyes were sunken, hands shrivelled and livid, tongue quite cold; pulseless on admission, 4 p.m. Abdomen was slightly distended.

4 p.m. Purged like rice water.

7.30 a.m. Almost pulseless. Tongue cold, skin warmer. No vomiting, no purging.

12.30 midnight. The pulse was with great difficulty felt. Vomited a reddish fluid.

Sept. 1st. At 4.30 a.m. she was purged. Temperature in axilla 94, in the rectum 100, respiration 33 a minute.

9.30 a.m. Passed a dark watery evacuation.

After this she was purged a few times, apparently the effect of some castor oil which she had taken. On September 2nd, 10 a.m., she died.

This poor woman, when admitted, was in decided collapse, and pulseless. During the first 12 hours that she was in the hospital she was purged only twice, and she vomited several times.

I might give examples of this kind if necessary; we have, instead of recording more such cases separately, introduced them in the table at p. 12.

I propose next to ascertain if there is any relation between the amount of the vomiting and purging and the intensity of the algide symptoms, what is the ratio between the two.

In order to do this I beg leave, first, to record a few cases in which the algide symptoms were very severe.

George Mansfield, aged seven, admitted into the Cholera Hospital September 10th, at 3.40 p.m. He was first taken ill about 2 o'clock in the afternoon, that was one hour and forty minutes before admission, with vomiting, purging, and cramps in his legs and thighs. At 7 p.m., about $3\frac{1}{4}$ hours after admission, and $5\frac{1}{4}$ hours after the attack first set in, he was pulseless, hands livid, lips livid, pupils dilated, and he was in collapse.

12 o'clock midnight, he was purged twice; rice-water looking fluid with gelatinous looking pieces in it. He subsequently passed into imperfect reaction, and died September 12th, 9.10 a.m.

In this case the algide symptoms set in very rapidly, $3\frac{1}{2}$ hours after

admission, and $5\frac{1}{4}$ hours after the attack commenced, the patient was in undoubted collapse.

The first nine hours that the patient was in the hospital he was only purged twice.

Another case in which there were very severe algide symptoms, and the patient was in decided collapse, yet there was no purging for some hours.

Bridget Doyle, aged 50, admitted into the hospital October 10th, at 9.15 p.m. She was quite well, and she had her dinner with her family at 1 o'clock mid-day of the day of admission. At 3 o'clock in the afternoon of the same day frequent vomiting and purging had set in, and she was cramped in her legs. On admission at 9.15 p.m., that is, $6\frac{1}{4}$ hours after seizure, she was pulseless, tongue cold, hands cold, livid, and sodden, lips slightly livid, choleraic voice and aspect.

No purging or vomiting since 7 p.m.; respiration 36, laboured.

10 p.m. Vomited yellow fluid with dark-coloured flakes in it.

11 p.m. She was much cramped in the legs.

11th, 3 a.m. Pulse just perceptible; respiration 48, very laboured; eyes much sunken; no vomiting, no purging; restless, throws off the bed clothes; colour natural and cheeks red.

5 a.m. Passed a pinkish stool in the bed.

6 a.m. Passed a large quantity of blood in the bed.

7 a.m. Livid, pulseless, apparently dying. She died October 11th, 7.45 a.m.

This patient was eight hours in the hospital without being purged once; she vomited very little, indeed only once; as she passed into imperfect reaction bloody evacuations appeared.

The attack set in suddenly, and $6\frac{1}{4}$ hours after marked symptoms commenced the patient was in deep collapse.

One more case of a somewhat similar kind.

Sarah Ann Quinn, aged 40, admitted August 30th at 9.30 a.m. She was first taken ill on the 28th with diarrhœa; on the 29th she suffered from diarrhœa. At 12 o'clock at noon on the 29th she got much worse, seized with cramp, and the purging became "excessive," or, as she described it, it was "shocking." On admission August 30th, at 9.30 a.m., she was livid, almost pulseless, tongue cold, eyes sunken, and choleraic voice; August 31st she died.

I venture to give one more example of this kind, that of a female.

Mary Ann B., aged 50. She was first taken ill October 14th, at 12 o'clock at noon, with vomiting and purging, watery evacuations. She was occasionally purged and vomited until October 18th, when she was taken much worse with cramps in her legs and hands; at noon she was said to have become livid. She was admitted into the Cholera Hospital, October 18th, at 9.30 p.m. She was then pulseless, tongue cold, face and hands cold, somewhat livid and sodden, lips livid, and she died October 19th, 9.45 a.m.

With the aid of this table we are enabled to examine the relation of the vomiting and purging to the algide symptoms. In each of the cases these symptoms were severe. All the cases were fatal.

The mean duration from the time of seizure to the time when admitted into the hospital with collapse was $8\frac{1}{2}$ hours. The shortest period was 1 hour 45 minutes; the longest term was 13 hours.

Several patients after their admission into the hospital in collapse were not purged, not even once. One patient was 15 minutes in the hospital and not purged, another $2\frac{1}{2}$ hours, one $3\frac{1}{2}$ hours, one 5 hours, one $5\frac{1}{2}$ hours, one 7 hours, one 12 hours, one 15 hours, without any purging. 10 patients were purged twice, 3 patients four times. In six cases there was neither vomiting nor purging. Eighteen of the patients were, when admitted, absolutely pulseless at the wrist.

No. 4.—Cases of Severe Collapse. A Table showing the Relation between the

No.	Name.	Age.	If any decided Premonitory Diarrhœa.	If Cholera Symptoms set in suddenly.	The amount of vomiting and purging before admission.	The degree of collapse while in the Hospital.
1	Maria Adams.	17	None -	Suddenly taken ill with violent pain in her stomach, 10 p.m. Sept. 16; quite well before; Sept. 17, purged very much; adm. Sept. 17, 2.30 p.m.	Seized Sept. 17th. Purged very much; vomited all day; cramps in legs.	Severe collapse; pulseless; very livid.
2	Harriett Bennett.	54	None -	Suddenly; quite well at 12 o'clock Sept. 17; at 2.30 p.m. taken ill suddenly after dinner; adm. 10.30 p.m.	Sept. 17th. Purged very much; vomited very much; cramps.	Severe collapse; pulseless; livid.
3	Mary Nicholls.	39	None -	Suddenly; was quite well yesterday; taken suddenly ill at 6 a.m. Aug. 26; adm. 12 noon, Aug. 26.	Seized Aug. 26th. Purged very much indeed; vomited twice; cramps in legs.	Severe collapse; temperat. axilla $92\frac{1}{5}$; pulseless.
4	Francis Mellicon.	$5\frac{1}{2}$	None -	Suddenly - - -	Oct. 5th. Vomiting; purging; no pain.	Pulseless; livid; resp. 40.
5	Ann Nicholls.	67	None -	Suddenly; first taken ill 6 a.m. Sept. 19; adm. 3.30 p.m. Sept. 19.	Sept. 19th. "Vomiting and purging continually until admission."	Collapse marked; pulse perceptible; tongue cold; hands and lips livid.
6	Bridget Doyle.	50	None -	Suddenly; she was quite well Oct. 10, 1 o'clock mid-day; taken ill at 3 p.m., vomiting and purging; adm. Oct. 10, 9.15 p.m.	Oct. 10th. Vomiting and purging frequent. Cramps in legs.	Collapse extreme; pulseless; livid.
7	Harriet Aldridge.	5	None -	Suddenly; Oct. 2, went to bed as usual; at 12 midnight she began to vomit violently, purging every 10 minutes; adm. 2.30 a.m. Oct. 3.	Oct. 2nd. Began to vomit violently; purged every 10 minutes; turned cold and livid about the mouth and eyes.	Collapse marked.
8	Sarah Perks.	7	None -	Suddenly; first taken ill Oct. 13, 1 a.m.; quite well when she went to bed; awoke up suddenly with vomiting and purging; adm. Oct. 13, 5 a.m.	Much purging and vomiting.	Collapse severe; pulseless; choleraic voice; lips livid.
9	Ellen Proctor.	26	None -	Suddenly; Sept. 25, 9 a.m. quite well; 10 a.m. taken suddenly; adm. Sept. 26, 1 a.m.	Vomiting and purging very violently.	Admitted in extreme collapse, evidently dying; lived only 15 minutes.
10	Johanna Collins.	60	None -	Suddenly; quite well 8 a.m. Aug. 25; taken ill while eating her breakfast; adm. Aug. 25, 1.20 p.m.	Violent retching. "Purging and cramps. Can't say how often purged."	Collapse severe; pulseless.
11	Eliza Brooks.	15	None -	Suddenly; appeared quite well until 11 p.m. Sept. 25, then turned faint; adm. 8.30 a.m. Sept. 26.	Faintness, vomiting, and purging. Does not say if severe or not.	Collapse severe; pulseless.
12	George Mansfield.	7	Not stated.	Suddenly taken ill 2 p.m. Sept. 10; adm. 3.40 p.m. Sept. 10.	Vomiting, purging, and cramps in legs.	Collapse severe; pulseless; livid.
13	Sarah Ann Quinn.	40	Yes -	Suddenly taken worse -	Vomiting and purging very much; she got rapidly worse.	Collapse severe; pulseless.
14	Sarah Smith.	61	3 days' diarrhœa.	No - - - -	Taken worse 29th Aug. noon, 12; purged "shocking."	Collapse severe; pulseless.

AMOUNT of the VOMITING and PURGING and SEVERITY of the ALGIDE SYMPTOMS.

Amount of purging after admission into Hospital.	The Amount of vomiting after admission into Hospital.	How many Hours did the Patient live after characteristic Symptoms set in.	Duration in Hospital.	Result.	Condition on Admission.	How long after Seizure before admitted into Hospital.
Purged four times. "Purged largely through the bed."	Vomited 6 times.	45 hours -	17 hours -	Died	Collapse; livid	4½ hours.
Nine bloody evacuations; no purging for seven hours after admission.	2 times - -	17½ hours -	13 hours 40 minutes.	Died	Collapse; livid; pulseless.	4 hours.
Purged twice; had Ol. Ricini ʒx. in 10 hours.	Vomited once	26 hours -	20 hours -	Died	Collapse great -	6 hours.
Purged once; rice-water evacuation large; very offensive smell.	Vomited once a great deal.	14 hours 50 minutes; saline transfusion into veins.	10 hours 50 minutes.	Died	Not in collapse on admission; collapse severe 4 hours after admission.	4 hours; 8 hours after seizure in collapse.
Purged six times, of this number two bloody evacuations.	Vomited often, does not say how many times.	37 hours; saline transfusion into veins.	16 hours -	Died	Collapse marked	9½ hours.
No purging for seven hours after admission; two bloody evacuations.	Vomited once	16 hours 45 minutes.	10½ hours; saline transfusion.	Died	Collapse extreme	6 hours 5 minutes.
Purged three times -	Vomited twice	11 hours - -	8 hours; saline transfusion.	Died	Collapse marked tongue cold; pulse only just perceptible.	2½ hours.
Not purged at all in hospital, that is, for 5½ hours.	Vomited once	10½ hours -	5½ hours -	Died	Collapse severe; pulseless.	5 hours.
No purging - -	No vomiting -	13 hours 15 minutes.	15 minutes	Died	Collapse; dying state.	13 hours.
No purging while in hospital, that is, for 4½ hours.	No vomiting in hospital, about 4½ hours.	9½ hours -	4½ hours -	Died	Collapse severe; pulseless.	5 hours 20 minutes.
No purging in hospital.	No vomiting while in hospital.	13 hours -	2½ hours -	Died	Collapse severe	10½ hours.
Purged two times, the first nine hours after admission; then went into imperfect reaction, and purged four times, once bloody.	No vomiting -	20 hours -	18 hours -	Died	Collapse severe; pulseless.	1 hour 40 minutes.
Only purged twice during the first 12 hours after admission, then passed into reaction.	Vomited several times since admission.	2 days - -	1 day 23 hours.	Died	Collapse; pulseless.	Got rapidly worse in 2½ hours.
Purged twice the first 12 hours after admission; afterwards bloody evacuations.	No vomiting mentioned.	48 hours -	39 hours -	Died	Collapse; pulseless.	9½ hours.

CASES OF SEVERE

No.	Name.	Age.	If any decided Premonitory Diarrhœa.	If Cholera Symptoms set in suddenly.	The amount of vomiting and purging before admission.	The degree of collapse while in the Hospital.
15	Emma Mills.	39	3 days' diarrhœa.	No - - - -	Taken worse Sept. 24th; vomiting, purging, cramps frequently.	Collapse; 93$\frac{3}{5}$ axilla
16	William Mellicon.	12	None -	Suddenly; was quite well yesterday at work; taken ill 8 p.m. Oct. 3; adm. Oct. 4, 7 a.m.	Vomiting; purging very much all night; cramps in legs.	Collapse extreme; pulseless.
17	Arthur Grant.	53	None -	Suddenly; Sept. 25, 10 p.m., first taken ill; adm. Sept. 26, 7.15 a.m.	Vomiting and purging, and cramps. Does not say if great.	Collapse severe; pulseless.
18	Edward Mellicon.	2½	None -	Suddenly; first taken at 8 p.m. Oct. 3, with vomiting and purging; adm. Oct. 4, 7 a.m.	Vomiting; purging frequent; vomiting; purging continued all night.	Collapse; pulseless
19	Thomas Ellis.	12	None -	Suddenly; Sept. 10, 9 p.m., taken ill coming from work; adm. Sept. 10, 9.10 p.m.	Vomiting and purging very much.	Collapse; pulseless
20	Ann Harmer.	62	None -	Suddenly - - -	Vomiting; purging; cramps in legs.	Collapse severe; pulseless.
21	Catherine Poley	31	None -	Suddenly; Oct. 4, 12 midnight, first taken ill; adm. Oct. 5, 1 p.m.	Vomiting and purging frequent; cramps in legs.	Collapse marked; pulse just perceptible.
22	Elizabeth Morice.	51	None -	Suddenly - - -	Vomiting and purging violently for more than 12 hours.	Collapse very great; pulseless.
23	Mary Buck	31	None -	Suddenly; taken ill at 3 a.m. Sept. 16; adm. 9.30 a.m. Sept. 16.	Purged and vomited very often.	Collapse very great; pulseless.
24	Charlotte Moss.	49	None -	Suddenly; first taken ill Sept. 9, 7 a.m.; quite well before; adm. Sept. 9, 1.45 p.m.	Vomiting and purging very much; cramp in legs.	Collapse; pulseless
25	Emma S. Andrews.	41	None -	Suddenly; first taken ill Sept. 13, 9 a.m.; was going out to work and was taken suddenly ill in the street with cramps; vomiting and purging; adm. Sept. 13, 2.15 p.m.	Vomiting and purging -	Collapse - - -

COLLAPSE—*continued.*

Amount of purging after admission into Hospital.	The Amount of vomiting after admission into Hospital.	How many Hours did the Patient live after characteristic Symptoms set in.	Duration in Hospital.	Result.	Condition on Admission.	How long after Seizure before admitted into Hospital.
No purging during the first 12 hours of admission; afterwards bloody evacuations.	Vomited two times the first 12 hours.	33 hours -	20 hours -	Died	Collapse -	13 hours.
No purging after admission.	No vomiting after admission.	10 hours 45 minutes.	3 hours 45 minutes.	Died	Collapse extreme	11 hours.
No purging for 12 hours after admission; after that bloody evacuations.	No vomiting.	24 hours 30 minutes.	About 12 hours.	Died	Collapse severe -	12 hours 15 minutes.
Purged once the first 10 hours after admission; purged 10 times afterwards.	Retching -	51 hours -	40 hours -	Died	Collapse; on admission pulse distinct; three hours afterwards pulseless.	11 hours.
Purged six times -	Vomiting not excessive.	About 17 hours 50 minutes.	17 hours -	Died	Collapse severe; pulseless.	10 minutes; in 3 hours pulseless.
Purged once $1\frac{1}{2}$ hours after admission, not afterwards.	No vomiting mentioned.	17 hours -	$6\frac{1}{2}$ hours -	Died	Collapse severe; pulseless.	10 hours 30 minutes.
On admission said that she had not been purged since 4 a.m., that is, nine hours. Purged once the first 3 hours after admission; then saline fluid injected into the veins.	Vomited frequently.	22 hours -	9 hours -	Died	Collapse marked	13 hours.
No purging after admission; only lived $1\frac{1}{2}$ hours in the hospital.	No vomiting while in hospital.	29 hours -	1 hour 50 minutes.	Died	Collapse great -	28 hours.
No purging for 11 hours after admission; after that entering reaction, and purged three times.	Vomited 20 times in two days.	4 days 17 hours	4 days 11 hours.	Died	Collapse; pulseless.	6 hours.
No purging for 6 hours after collapse had set in.	Vomited several times.	3 days 14 hours	3 days 1 hour.	Died	Collapse; pulseless 13 hours after seizure.	13 hours after seizure in complete collapse.
6 times purged the first 7 hours after admission; after that saline fluid transfused into the veins.	Felt sick, but no vomiting.	$20\frac{1}{4}$ hours -	15 hours -	Died	Collapse; pulse just perceptible.	$5\frac{1}{4}$ hours.

APPENDIX.

No. 8.
On the Clinical Characters of Cholera, 1866, *by Dr. Sutton.*

The above evidence clearly shows that when patients went into collapse the vomiting and purging very greatly diminished, and in some cases entirely ceased.

This observation bears out what Dr. Parkes and other excellent observers have stated, that "at a period of the cases when the algide "symptoms were most fully developed—viz., in the last five hours of "life—the purging ceased."

I had many opportunities of seeing that some of the worst cases of cholera, cases which seemed almost sure to prove fatal, had very little, and often not any, purging while in the hospital, and those cases in collapse, on admission or very soon after admission passed into that condition.

And I cannot but agree with what has been stated by Dr. Parkes that "where the algide symptoms were prominent throughout, and which cases were consequently the most malignant and the most rapidly fatal, the passage of fluid from the intestine was oftentimes very trivial in degree and shortened in the period of its occurrence."

And in illustration of this I would refer to the table just given. At No. 7 is the case of a patient who was found to be in collapse $2\frac{1}{2}$ hours after the vomiting and purging had first set in. She was only purged three times, and vomited twice while in the hospital. She was only ill 11 hours altogether. No. 8 is another case. Five hours after the vomiting and purging set in she was in collapse and pulseless. She was $5\frac{1}{2}$ hours alive in the hospital, and during that time she was not purged once, and only vomited once. She lived $10\frac{1}{2}$ hours after the characteristic symptoms set in. No. 12.—One hour and forty minutes after the vomiting and purging set in suddenly, this patient was in complete collapse and was pulseless. He was nine hours in collapse, during which time he had only two stools. He died 20 hours after he was seized. No. 23. The patient was $6\frac{1}{2}$ hours after vomiting and purging set in in collapse and pulseless. He was 11 hours in the hospital without being once purged; he vomited a great many times. On entering reaction he was purged three times. He lived 4 days 17 hours.

The patients included in the above table previous to their admission into the Cholera Hospital had suffered from vomiting and purging. In every instance this was the case. In 19 out of the 25 cases there had been very much purging and vomiting. The discharge of fluid from the intestines had been evidently very great; after admission there was little loss of fluid. To be able to estimate, however, to what extent the collapse was due to the loss of fluid only, it would be necessary to have some evidence of the amount of water discharged into as well as out of the bowels.

That the size of the stools vary very much experience has shown. Some patients were purged very little at a time, and others passed very large watery evacuations.

I regret that I have not any evidence to show the quantity of fluid that was in any case so discharged.

I next propose to inquire if there were, as a rule, severe algide symptoms in the cases characterized by continued and protracted vomiting and purging in the "cold stage." By "continued and protracted" I mean when the vomiting and purging were many times repeated, going on for several hours, and that while the patient was in the hospital and under my eyes; therefore the very opposite of the class of case just named, in which, as the reader will remember, purging and vomiting almost, and in some, entirely ceased for hours.

I was able to fully satisfy myself that the cases characterized by the most continued purging and vomiting were not by any means the worst

class of case—for the most part the very opposite. In such cases the mortality was comparatively low, and then algide symptoms came on slowly, and in many of such cases there were no very severe algide symptoms, and it was the exception of any of the cases to pass into collapse.

The following is a good illustration showing the correctness of this statement; it also shows the class of case which tends to do well; where, for instance, there is a great deal of purging and vomiting, but no well-marked algide symptoms.

Emily H., aged 17; works at a trimming manufactory; admitted October 5th, 7 p.m. She stated that she was first taken October 5th, 2 a.m. Purged frequently; "rice-water" looking fluid evacuation. She began to vomit at 5 a.m.; the vomiting and purging continued frequently. 3 p.m. cramps in the feet and legs set in. On admission her eyes were sunken, tongue cold and white, pulse distinct, colour natural, lips natural; vomited rice water, also purged rice water.

8.15 p.m. Purged evacuation, rice water.
8.30 „ Vomited rice water.
8.40 p.m. Purged evacuation rice water.
9. 0 „ Purged evacuation like rice water.
10. 0 „ Pulse distinct, tongue cold and white, face pale, voice feeble, some parts of the body warm.
12 midn. Purged rice water looking fluid, with jelly-like pieces in it.

October 6th :—
1. 0 a.m. Purged rice water, with gelatinous looking matter.
2. 0 „ Purged do. do. do.
2.30 „ Vomited.
3. 0 „ Vomited rice water looking fluid.
3.15 „ Purged rice water and gelatinous looking matter; she vomits continually, especially after drinking; was very restless up to 5 a.m., when she went to sleep.
7. 0 „ Vomited rice water.
8. 0 „ Vomited rice water; she has a discharge of blood from the vagina.
9. 0 „ Purged rice water looking fluid, with a tinge of yellow.
9.30 „ Vomited.
10. 0 „ Vomited and retched a great deal; the pulse is distinct, she is not livid, skin warm, hands warm.
12.30 noon. Vomited yellow fluid.
3. 0 p.m. Has slept for two hours; vomited a quantity of emerald green fluid.
5. 0 „ Vomited a yellowish green fluid; purged, evacuation yellow pea soup looking.
6. 0 „ Has slept since 5 o'clock.
6.30 „ Apparently doing well.
7. 0 „ Vomited green fluid.
7.15 „ Vomited as before; retches violently.
9.30 „ Vomited light emerald fluid.
11.30 „ Vomited green fluid.
12.30 midnight. Vomited a large quantity as above; sleeping quietly since; lips red, respiration 20.

7th.
3. 0 a.m. Vomited green fluid as above; purged a little brown grey fluid.
5. 0 „ Is very restless and distressed; vomited green fluid.
8. 0 „ Vomited a green fluid.
9. 0 „ Tongue coated and warm, pulse distinct, colour natural, skin warm, going on favourably, sleeping naturally.

10. 0 „ Purged yellow fluid.
12. 0 noon. Do. do.
From 1 p.m. to 11.30 p.m., purged three times.

8th.

1.30 a.m. Passed urine; purged, evacuation brown fluid.
6 a.m. Has slept a good deal; vomited a green fluid.
9 a.m. Colour natural; eyes closed; pulse distinct; sleeping naturally.
From 11 a.m. to 9 p.m. purged five times; evacuation bile-stained.

9th.

3 a.m. Purged; no vomiting.
6 a.m. Has slept a good deal; no vomiting.
9 a.m. Doing well; passed urine.
12 noon. Tongue very much coated with fur.
3 p.m. Purged.
From 4 p.m. to 9 p.m. purged four times; no vomiting; convalescent.

From this time she continued to do well, and was discharged Oct. 20th, 1866.

From 8.15 p.m. on the day of admission to 5 a.m. next morning this patient was purged seven times, all this time the ejections being of the rice water character, and she vomited a very great many times. When it is borne in mind that the vomiting and purging set in about 5 a.m., that these symptoms were repeated frequently until 5 a.m. next morning, that is, for 24 hours, it is quite clear the patient must have discharged a large quantity of fluid, and yet during no part of the illness was there any collapse. It is further to be noticed that there were no severe algide symptoms in this case. The tongue was cold and white, voice was feeble, but there was no lividity, face was pale, and the pulse throughout was distinct.

Other cases similar to the last could have been brought forward with the object of showing that it by no means follows because a patient is very much purged and vomits violently and very frequently, that he is in a worse condition than another patient who vomits and is purged much less. I have brought forward evidence in the last table which clearly showed that the algide symptoms were not in regulated proportion to the frequency of the vomiting and purging. I have shown that a patient may be purged hour after hour, may almost continually vomit, yet may not pass into collapse; whereas another patient is purged and has vomiting for two or three or five hours, and passes into deep collapse. If the collapse be dependent solely on the loss of fluid, it is difficult to understand why in the very class in which there is the protracted purging, there is the least collapse; and even on the assumption that one patient passes in two or three evacuations more water than another does in double the number, and admitting that it is so in some cases, we are yet called upon to explain how it is that a patient who is not purged at all, that is, has had no discharge from his bowels, dies very suddenly; that another who has only been purged four times passes into collapse and dies; while others are purged 20 or 30 times without ever showing any well-marked symptoms of collapse. It is difficult to conclude that one patient passes more fluid in one evacuation than another does in 20.

It appears to me that an explanation of this difficulty, to be satisfactory, must take into consideration not only the quantity of fluid withdrawn from the blood, but the rapidity with which it is withdrawn.

In the worst forms of cholera a considerable quantity of water and other constituents of the blood are withdrawn very suddenly from the system.

On referring to the table last given, it will be seen that there was a decided relation between the severity of the collapse and the rapidity and violence with which the cholera process set in and was carried on.

In 10 cases there was very much vomiting and purging; in 6 there were vomiting and purging, but it is not stated how much; in 3 the patients vomited, and were much purged; in 3 the purging and vomiting were very violent; in 1 the patient vomited and was purged continuously up to the time of admission; in 1 patient the purging was said, to use the patient's own words, to have been shocking; 3 patients were said to have been purged every 10 minutes.

And I may here be permitted to refer to a case in which there was an opportunity of seeing how violently the symptoms might set in, how rapidly the fluid might be discharged from the system, and how quickly the algide symptoms might be developed, and the patient might pass into collapse.

The patient, Sarah Mansfield, aged 5 years, was admitted into the Cholera Hospital, September 11th, at 4 a.m. The afternoon previous she was running about quite well. Diarrhœa came on in the evening, and as her mother had just died of cholera the friends got alarmed, and sent her into the hospital at 4 a.m. On admission she had not any distinctive marks of cholera, her pulse was good, but she looked tired and she "felt sick;" her skin also felt colder than natural. She was in the hospital about an hour when she began to vomit "constantly," and was purged the same. Her eyes became sunken, and at 5.45 a.m., that is one hour and forty-five minutes after admission, her tongue was cold, her hands were livid, her pulse was feeble but distinct, and she had no cramps. The sister in charge of the ward states at this hour, " her symptoms have come on with the utmost rapidity; at 6 a.m. her " pulse was 158 and very weak; respiration 22 per minute." Mr. Mackenzie reports, "This case has rapidly got worse. From 6 a.m. " to 8 a.m. the vomiting and purging continued very frequently, evacua- " tions consisted of rice-water looking fluid. At 9.30 a.m., she was " pulseless, with very livid lips, tongue quite cold, breathing 28 a minute. " She was at this hour purged and very restless. From this hour up to " 6 a.m. next morning she was not purged once, and only vomited five " times," that, is during $9\frac{1}{2}$ hours. She died in advanced reaction on September 17th.

The patients who died most quickly were those in whom the purging and vomiting commenced suddenly, were rapidly repeated, and in whom the collapse set in early. This would appear to indicate that it is not simply that so much fluid is withdrawn from the blood, but further that so much fluid is withdrawn comparatively quickly and suddenly, and we are therefore led to suspect that besides the loss of fluid there is another element in the causation of collapse, which is probably a shock to the nervous system.

I use the word shock simply as an expression to indicate that the nervous system is probably taken by surprise, without at all attempting any further explanation of such phenomenon.

Now and then the effect of such shock is seen in the sudden death of the patient before he has time to be purged. I would refer to what I saw in the post-mortem examination of a patient who died of the so-called "Cholera Sicca" in the London Hospital last autumn.

Before doing so, permit me to remark that the appearances were not inconsistent with the supposition that the patient's death was due to some sudden and fatal impression on his nervous system, and not simply to the loss of a quantity of fluid from blood. The morbid appearances differed very much from what is seen in cases in which death has taken place after a good deal of purging and vomiting.

APPENDIX.

No. 8.
On the Clinical Characters of Cholera, 1866, *by Dr. Sutton.*

A well-made man, about 40 to 50 years of age, was brought into the London Hospital dead. The history given of him was as follows:—A short distance from the hospital he was seen walking along the pavement; he suddenly cried out, bent forward, put his hand on his belly and fell. He was picked up, and brought at once to the London Hospital, and before he was got there he died. On the post-mortem table, it was noticed that there was a discharge of blood from his nose, small in quantity, and not any from his ears. It was suspected, amongst other things, as at that time we knew little of his history, that he might have fractured skull, or have some brain disease. I therefore very carefully examined his brain and skull, and found both healthy. I next opened his chest. The lungs were not collapsed, and the pleuræ was for the most part healthy. On opening the pericardium it was found to be healthy, and on examining the heart there was nothing to attract particular attention. The left ventricle was not contracted, and it contained a moderate quantity of fluid blood. The right ventricle was more distended than the left, and also contained a quantity of blood. The valves and muscular tissue, to the naked eye, looked healthy. The lungs were crepitant—on section they presented their normal colour, in parts they were soft, and more easily broken down than natural; on squeezing any portion between the two hands a large quantity of fluid exuded. The lungs were evidently very œdematous. This was so much so, that I remarked to Dr. James Jackson, the resident medical officer, that the man has probably, from the appearance of his lungs, died of Bright's disease, after an epileptiform seizure. His liver was apparently healthy—it might be a little fatty, but no very striking change. His kidneys were next examined, to see whether there was any reason to think he had died of Bright's disease. The capsules readily separated, the surfaces of the kidneys were perfectly smooth, their colour was natural. The cortical portions were not diminished, and apparently healthy. There was nothing peculiar in the way the intestines were placed—nothing like the compact arrangement seen after death in collapse of cholera. I next proceeded to remove the intestines, and on opening the duodenum a large quantity of a pale canary-coloured opaque fluid escaped. I remarked at the time to Dr. James Jackson, that looks very much like what we see in the upper portion of the bowels in patients dying of cholera; and if this patient has died of that disease, we shall find the fluid get thinner and thinner as we approach the ileum. For having at that time examined a good many intestines of those dead from cholera, I had many times seen such appearances. Continuing the examination, the fluid became thinner and more watery looking, until in the ileum it was ordinary rice-water in large quantities. The small intestine was full of fluid. On opening the large intestine it was found to contain a large quantity of semi-solid and solid fæces. There was not here anything like rice water. The mucous membrane of the ileum in its lower part was somewhat congested here and there, but was otherwise healthy; the spleen was normal. The spinal cord was not examined. I regret very much that I have not preserved the weights of the organs, but I am able to say from memory that the lungs were not abnormally light.

The morbid appearance of all the organs in this case, excepting the contents of the rice-water looking ileum, were strikingly different from what was seen usually after death from cholera, especially after death in collapse. In the case just named, the arterial portion of the vascular system, judging from the normal colour and appearance of the organs, contained its ordinary quantity of blood. The blood was not found for the most part on the venous side of the system, as is seen in collapse. The lungs were not strikingly pale in their anterior portions, and they did not become rapidly scarlet after exposure; the lungs were

not shrunk nor collapsed; the cortical portions of the kidneys were not of a blue-grey colour, and the medullary of a claret colour, and the veins between medullary tubes looking like claret-coloured lines; nor were the veins beneath the peritoneum seen as if injected pink on a white ground. The intestines were not lying back in the abdomen, and closely packed together, as was seen when death had taken place in collapse.

The small intestine was filled with fluid, and the presence of a quantity of solid fæcal matter in the large intestine clearly showed that there had been no discharge of fluid out of the intestine. There was no evidence of great obstruction through the lungs. The organs, especially the lungs, were not abnormally light. I weighed the lungs at the time, unfortunately the amount was not put down in the record. There was not the least anæmic appearance.

The sudden way he died, the absence of any apparent change in any of the vital organs, would lead us to conclude that he died from so-called "shock." What that means I do not know; and further still it may very properly be said that the induction is so incomplete that it is simply begging the question. Yet it will be granted, I have no doubt, that experience has amply shown that any sudden and unexpected change in any vital part of the body is liable to be followed by immediate death; and in such cases the appreciable effects, judging by the post-mortem appearance, are, in comparison with what takes place when death is slower, almost insignificant.

What we would probably all contend for is that in such cases there must be something more than the mere loss of water to account for death.

There may have been in this patient, and it is not improbable, some peculiar condition of body which rendered this patient more than ordinary liable to die after comparatively slight change in his system.

The diminution, and in some cases cessation, of purging in collapse would lead us to inquire whether the collapse in cholera does not play the same part as syncope does in hemorrhage. Syncope is brought about by the loss of blood, especially if a quantity of blood is suddenly taken from the body. Collapse in cholera appears to be brought about by a quantity of fluid being somewhat suddenly withdrawn from the system. In both a quantity of fluid may go on escaping for some time, if slowly discharged, that is, for some hours, without producing the same effect. It might further be asked if the system does not seek to accomplish the same result in both syncope and collapse. In one she endeavours to check the bleeding by retarding the circulation, and by this means allowing the fluid to coagulate in the bleeding vessels. In the other she seeks to arrest the flow of fluid from the mucous membrane of the intestinal canal by arresting and greatly diminishing the blood circulating through the capillaries of the mucous membrane.

Collapse differs from syncope in one very striking feature; whereas a patient may pass into syncope, recover, and the bleeding may return. Again, he may pass into syncope, and a second time the patient come out of it, to be followed by the return of the hemorrhage. Such is not the case in cholera; when a patient comes out of collapse everything is changed. The patient has ceased to pass rice-water evacuations, and, if going on well, begins to pass evacuations tinged with bile. The evacuations have lost to a great extent their watery character. Although the first few stools passed by the patient soon after entering reaction may be more or less watery, yet they soon, in two or three hours, lose that character, and go on until they consist for the most part of bile and mucous of the consistence of jelly.

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When a patient died in advanced reaction, or was in complete reaction, the different organs of the body were found to have regained their weight, sometimes even weighing heavier than usual; this was especially the case with the lungs. The weight was increased only in advanced or in complete reaction. In imperfect reaction such was not the case. If the patient happened to die before entering into the stage of complete reaction, the internal organs, especially the lungs and spleen weighed much lighter than normal.

The system is capable of entering some distance into reaction before much water has been absorbed.

If the lightness of the organs depends on the loss of the water, then we have evidence in the diminished weight of the organs to show that the system is capable of entering into early reaction before taking up much water, unless we assume that water has been absorbed before going into reaction, and again lost by purging or vomiting just before death.

I have brought forward the weights of the organs of the five cases that died in the London Hospital. All of the patients, judging from the contents of the intestine, had entered some distance, but not far, into reaction, yet the organs were found very light.

There are only five cases, but one probably would be sufficient; the evidence of commencing reaction was seen in the condition of the small intestine, where the mucous membrane was bile-stained, or the contents of the bowels bile-stained. These signs I have regarded as evidence of reaction.

All the cases brought forward were adults from 30 to 50 years of age.

The evidence of reaction. Contents of the Intestine.	Age.	The weights of the different organs in persons dying in early reaction.					Appearance of the Intestine.
		Lungs.	Heart.	Liver.	Spleen.	Kidneys.	
A yellowish white gelatinous fluid in duodenum, jejunum. In the ileum, cæcum, and large intestine a quantity of greenish yellow bile-like fluid.	35	R—15 oz. L—$14\frac{1}{2}$ oz.	$7\frac{3}{4}$ oz.	3 lbs. 1 oz.	$1\frac{3}{4}$ oz.	$6\frac{1}{4}$ oz.	—
Reddish-brown fluid in intestine. Intestinal mucous membrane very much congested.	50	R—$11\frac{1}{2}$ oz L—$9\frac{1}{9}$ oz.	$8\frac{1}{2}$ oz.	2 lbs. 9 oz.	$1\frac{1}{2}$ oz.	$7\frac{3}{4}$ oz.	The mucous membrane of the ileum largely congested, parts were clear, granular, and denuded of epithelium. Intestine contained a reddish-brown fluid.
Small intestine contained a thick greenish-brown bile-stained fluid; large intestine a brown-looking fluid.	32	R—11 oz. L—9 oz.	8 oz.	$2\frac{1}{2}$ lbs.	$3\frac{1}{2}$ oz.	9 oz.	Duodenum, jejunum, and ileum were deeply congested.
Intestine bile-stained, contains dark-greenish fluid.	32	R—$13\frac{1}{2}$ oz. L—$11\frac{1}{2}$ oz.	9 oz.	4 lbs. 4 oz. Appears fatty, a pale fawn colour.	$2\frac{1}{2}$ oz.	9 oz.	Small intestine slightly congested in parts, bile-stained in the upper part. Solitary glands, enlarged mucous membrane of the cæcum, and large intestine pale.
Biley-looking fluid in the intestine.	45	R—15 oz. L—13 oz.	Not given.	Not given.	$3\frac{1}{2}$ oz.	Not given.	Ileum congested. Mucous membrane of the small intestine bile-stained.
Bile in the intestine.	30	R—$8\frac{3}{4}$ oz. L—7 oz.	8 oz.	3 lbs. 8 oz.	$3\frac{3}{4}$ oz.	13 oz.	Ileum extremely congested.

The average weights of the lungs were 23 oz.; of the spleen, $2\frac{1}{2}$ oz.; of the heart, about $8\frac{1}{2}$ oz.; kidneys, 9 oz.; of the liver, the average weight was 3 lbs. 4 oz.

In the lightness of the lungs and spleen we have the same condition as is usually seen in death during collapse. The weight of the liver and of the kidneys are liable to vary a good deal.

It was instructive to notice how quickly a patient would pass from the condition of collapse into that of reaction, and that without the aid of any drugs.

The condition of collapse sometimes very quickly disappears.

Patients were seen pulseless, livid, wakeful, with the choleraic voice, and one or two hours afterwards the lividity had been replaced by flushed cheeks, pulse had become distinct, tongue warm, and the choleraic voice been replaced by the busy delirium.

We remember the case of a child that was very livid and pulseless, hands livid and cold, and showed all the well-marked symptoms of severe collapse. About three o'clock in the afternoon he gave a loud scream, as if in pain, and about one hour later he had regained his natural colour, his pulse had become distinct, his skin was warm, and he appeared to be doing well; but soon after this he was seized with epileptiform attacks and died.

In more favourable cases the collapse passed away more gradually. The wakefulness which was so characteristic of true collapse gradually gave place to sleep, the colour returned, the pulse became distinct and more perceptible, and in some cases the patients slept quietly for some time.

Imperfect reaction.

It was difficult indeed in some cases to say whether a patient had died in collapse or in imperfect reaction.

When all the algide symptoms were present it was an easy matter, but when some of such symptoms were present combined with other symptoms that usually characterize reaction, it was found very difficult to decide.

I have seen patients who were said to have died in collapse show signs, when on the post-mortem table, of having died in early reaction, and that even when the thermometer has been taken to be the guide.

My experience would lead me to state that the thermometer is of all single guides the best, still it is not one that can be absolutely relied on,—unless the temperature in the axilla be very low indeed, and in the rectum very high. If the temperature in the axilla be 92, in the rectum 102, I then should have no doubt that the patient is in collapse; if, however, the temperature in the axilla was 95 or 96, I should not be prepared to say that the patient is not in imperfect reaction.

Some parts of the body appear to pass into reaction before others.

All parts of the body in some cases appeared not to go into reaction at the same moment. My attention was called to this point while making the post-mortem examinations at the London Hospital; I was struck with the fact that in some cases the lungs were pale in their anterior portions, and of a darker colour behind and at the bases, at other times congested. The pale-looking portions rapidly became scarlet on exposure to the air; the lungs were dry and contained little blood, and weighed very light. The right side of the heart much distended with blood, the left ventricle contracted. The capsules of the kidneys readily separated. The stellate veins on the surface, were well marked, the cortical portions of a bluish grey or slate grey colour, and the medullary portions a claret colour, such appearances as are ordinarily seen in death during collapse; in the same bodies, the intestines were not lying back and closely packed together, and the peritoneal surface had for the most part vascular appearance, and on opening the

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intestine there was bile-stained mucus throughout the entire duodenum and jejunum, and yellow-coloured stool in the ileum.

At another time I have seen the lungs congested throughout, the kidneys also to some extent, and on opening the intestine there was not a trace of bile, but simply thick barley-water-like contents, or a thick reddish grey fluid.

Imperfect reaction and bloody evacuation.

After I had had charge of the Cholera Hospital for a few weeks, I recognized a class of case having the following symptoms:—

The patient was seen lying on his back, eyes open, looking very wakeful, mind collected, voice weaker than natural, at times the typical choleraic voice, colour natural, lips natural, complexion greasy, tongue sometimes cold, livid, of grey colour, and covered with white fur; at other times the tongue was warm, and coated with yellow fur. The hands were often a livid red colour, cold and shrivelled. The temperature in the axilla was generally lower than usual. Respiration was laboured, and generally accelerated, often 25, sometimes 40, a minute. The pulse at the wrist was only just perceptible, and very often such patients were pulseless; there was often no purging for hours together, and very little vomiting. There was often profuse perspiration in such cases, the face and hair wet with it. The patient would lie for hours like this, and even one or two days.

So many cases of this kind came under my notice that I was in the habit of saying that if a patient ill with cholera is pulseless, has a natural colour, greasy perspiring skin, and a coated tongue, he will in all probability pass bloody evacuations and then will certainly die.

In illustration of this remark I would beg leave to call attention to the following cases which this group of symptoms present, and they are excellent examples of this particular type of disease:—

Anna Harris, aged 36, a married woman, residing at Spitalfields, admitted into the Cholera Hospital, October 7th, at 12.30, midnight. Her history was as follows:—She was taken ill October 6th, at 1 a.m., with vomiting and purging of fluid, like rice-water, and with pain in the abdomen. She was quite well before that time. The vomiting and purging continued all that day "incessantly." She had violent cramps in her legs and feet.

On admission her pulse was feeble, 104; respiration 32. Her tongue was cold and sodden looking. Face and hands were cold. Natural colour in her cheeks and lips. Eyes a little sunken. She complained of pain in her back.

1 a.m. She has vomited rice-water looking fluid profusely ever since she came in. The voice choleraic. She is pregnant six months.

1.30 a.m. Vomited rice water. Says she feels faint, and thinks she is going to lose her sight. She has cramps in her legs. Eyes are more sunken. Lips livid.

2.31 a.m. She vomits "continually" clear water. Complains of a tightness in her chest. Cramps in her legs.

3.34 a.m. She continues to vomit as before. Cramps continue. Respiration is laboured. Pulse is scarcely perceptible. Tongue is cold. She is quite conscious, and answers questions rationally. She complains of great thirst.

4.30 a.m. She is pulseless. Respiration very laboured. She complains of great pain in her chest and says she cannot breathe. Eyes and face more shrunken. She vomits about every 10 minutes fluid like water. Cramps every now and then. Says that she is in pain all over her.

6.30 a.m. Vomits as before.

7 a.m. She vomits rather less. Tongue is very cold. Hands shrivelled,

about finger nails rather blue. Lips blue. Voice very feeble. She is quite conscious. She complains that she has not been able to pass urine for two days.

9 a.m. Pulseless. Hands are cold and livid. Lips are livid. Tongue is coated with dirty yellow fur. Vomits a great quantity at a time. Great thirst. To be wrapped in blankets wrung out in very hot water, and repeated every half hour; this was done, and continued up to 4 p.m.

11.20 a.m. Vomits, but less in quantity.

2 p.m. Vomits. Pulse is only just perceptible. Lies on her side. Tongue cold. Hands cold. Says she feels faint.

3 p.m. She has vomited bright yellow fluid.

5.30 p.m. Pulse is perceptible. Her voice has improved. Colour is natural. Cramps have entirely left her. Respiration 32.

7 p.m. Vomits fluid with fine flakes in it.

7.30 p.m. Respiration is laboured. Pulse scarcely perceptible. Vomits. Lies on her side. Says she does not think she will get through the cholera.

8 p.m. She vomits pale green water. She lies on her side and turns over occasionally.

8.30 p.m. She vomits as above.

9.30 p.m. She complains of great thirst, and calling out continually for water. Very restless, and turns from side to side.

11 p.m. Purged evacuation, yellow fluid. Vomits green water. Face red all over and cold.

12 midnight. Purged evacuation like the first stage of bloody evacuation.

Oct. 8th.:—

1 a.m. Says she feels easier. Pulseless. Quite conscious and voice good. Skin is warm.

1.30 a.m. Vomits green fluid.

2.30 a.m. Purged. The evacuation looked as if it contained blood; very offensive. Vomits green fluid.

4.0 a.m. Pulseless. Purged; a large evacuation in bed the same colour as before.

4.30 a.m. Vomits green fluid. Face and hands are cold and clammy. Tongue cold, but says she feels better, "first rate this morning."

5 a.m. Purged evacuation more like blood. Vomits green fluid with dark-green flakes.

7 a.m. Vomits green fluid. Purged evacuations look like blood.

8 a.m. She is pulseless. Tongue is cold and thickly coated with dirty-white fur. Respiration is very laboured. Says she does not think she is very ill, as she has no pain. Feels tired and wants to go to sleep. No lividity. Eyes are sunken. Colour is natural. Hands are cold, livid, and sodden.

9 a.m. Pulseless. Colour is natural. On allowing the evacuations to stand a sediment falls to the bottom, leaving a fluid that looks very much like water coloured with blood. Tongue thickly coated with yellow fur. Skin and tongue are warm.

9.30 a.m. She vomits grass-green-looking fluid.

1 p.m. Vomits as above, five or six times. She tries to get out of bed. Pulseless. Respiration 30 and laboured. She is very restless and distressed. Wanders; says she is being burnt alive. Hands and face very cold and sodden. Tongue is cold. No purging.

2 p.m. Vomits as above.

2.30 p.m. Her mouth is open. Face livid. Respiration very laboured, and body stiff, blue, and dying.

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She died 3.45 p.m., Oct. 8th. The above record shows that at 8 a.m., October 8th this patient was pulseless, and at the same time her colour was natural, her tongue was thickly coated with yellow fur, and her skin and tongue were warm, and at this time she was passing bloody-looking evacuations.

I venture to report another equally as instructive case :—

Ann Hughes, aged 67. Residence, Spitalfields. A widow.

She was first taken ill October 6th, at 2 a.m., with purging. She was much relaxed. 10 a.m., 7th; she attended as an out-patient, and obtained some medicine from this hospital.

Oct. 10th. She was taken very much worse at noon, with vomiting and purging and cramps; she vomited very frequently. She was admitted Oct. 11th, 8.15 p.m.

State on admission. Pulse is perceptible, but exceedingly feeble. Tongue cold and white. Eyes not much sunken Colour of complexion is natural. Choleraic voice. Says she feels so sleepy. Lips are rather livid. Skin cold. Hands cold, livid, and sodden. Respiration 24. Great thirst. She has been very much purged.

She has had very little food lately, owing to her great poverty, but has been in the habit of drinking beer and gin.

9 p.m. Vomited rice-water-looking fluid with flaky matter in it.

11 p.m. No purging since admission. Cramps in her legs.

Oct. 12th, 1 a.m. Her colour is natural. Her tongue is cold and white. Skin warm. Her pulse is just perceptible. Her hands are shrivelled and rather livid. Vomits fluid like mutton broth. Says she wants sleep and cannot get it.

3 a.m. Vomited a fluid the same as before.

4 a.m. Purged. Evacuation like thin beef tea.

5.30 a.m. Vomited the same as before.

6 a.m. Tongue warm. Hands sodden. Lies on her side. Wakeful. Pulseless.

6.30 a.m. Purged as before. She is very thirsty.

8.30 a.m. Pulse is just perceptible. Skin is warm. Her tongue is furred, sodden, and cold. She is very restless and wakeful. Her colour is natural.

10.30 a.m. Purged. Evacuation small in quantity ; looks like rice water with a tinge of pink.

11 a.m. Purged. A large evacuation. It is thought to be the first stage of bloody evacuation. No vomiting.

11.30 a.m. Purged ; second stage of bloody evacuation. Complains of much pain when she is passing the motion. Says she cannot pass urine, wishes she could. Abdomen distended. Pulse is only just perceptible. Hands cold and clammy. Wakeful and restless. No vomiting.

1 p.m. (midday). Purged ; evacuation contains more blood.

℞ Liq. Secale Cornutis ʒj.
Tr. Digitalis ♏x. Aquæ ℥j. 3 h.

Turpentine to be applied over the abdomen.

To be given soda water or lemonade as much as she likes to drink. Brandy, ℥ß every three hours.

2 p.m. Purged. Evacuation as before.

2.30 p.m. Purged ; evacuation turbid and contains blood.

4 p.m. Purged ; evacuation is turbid and contains blood. No vomiting. Says she wishes she could " be sick."

5.30 p.m. Purged ; evacuation as before.

6 p.m. Purged ; evacuation the same.

7 p.m. Purged blood ; evacuation smells very offensively.

8 p.m. Purged ; evacuation is pale.

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8.45 p.m. Purged; evacuation bloody as before.

10 p.m. Purged; evacuation bloody as before. Says that she feels "very queer;" that she wants to sleep, and she wonders why she cannot sleep. Her hands are cold. Body warm. She lies on her left side and turns about.

11 p.m. Purged; evacuation bloody as before.

11.30 p.m. Purged like clear blood.

12 p.m. Purged; evacuation like clear blood. No vomiting. Pulse only just perceptible. Respiration is 36 per minute and laboured.

Oct. 13th:—1 a.m. Purged; evacuation like blood.

2 a.m. Purged; evacuation same as last named.

7.30 a.m. Restless. Wandering; tries to get out of bed. Says her sister is coming to-day to bring her clothes, and that she may get up. There has been no purging since 2 a.m., and no vomiting. She has a desire to pass urine, but cannot; she asks for the pan frequently in order to try and do so. Bladder not distended.

8.30 a.m. Purged; evacuation looks like coagulated blood.

8.50 a.m. She changed very much; and at

9 a.m. she died.

In this case, on Oct. 12th, at 1 a.m., the pulse was only just perceptible, the tongue was cold, the hands were shrivelled and livid. The patient was very wakeful, and a few hours after this was passing undoubted blood evacuations.

In the table at p. 324 I have collected some particulars of a few more such cases.

This table embodies the particulars of 27 cases in which there were bloody evacuations.

The ages of the patients varied from 5 to 67 years. The greater part were persons of middle age.

In many cases there was a history of great and long continued poverty.

The bloody evacuations appeared on an average about 28·8 hours after the violent symptoms of cholera set in. In this calculation one case was excluded, as it was a very exceptional one; in the case referred to the bloody evacuations did not come on until seven days after the hour of seizure. The longest periods after the violent symptoms set in before bloody evacuations commenced were 51, 48, 48, 45, and 43 hours. The shortest period 14, 15½, 16½, and 18 hours.

One patient lived four days after she had passed a bloody evacuation; this was an exceptionable case; and even in this instance the patient did not continue to pass blood during four days; she passed two bloody evacuations, and died four days afterwards.

Patients, after passing bloody evacuations, lived, taking the average of 19 cases, only 12·2 hours. One patient died 2 hours 45 minutes after passing blood. One died 4 hours, one 5, another one 6, and another 8 hours afterwards.

The bloody evacuations followed the rice-water stools. As I have already said, the purging ceased for a time; after that the patient passed a pink-looking stool, or it was like barley water or gruel-like fluid, faintly-coloured pink. At other times the first motion had a pale-brownish colour, like chocolate cream, or cinnamon colour. The evidence of blood gradually became more and more established, until the evacuation looked like calves foot jelly coloured with port wine or strawberries. In one case, that of Edward Millicon, the blood was in such quantities that it coagulated in the vessel. When it was first shown to me I suspected that it had come from bleeding piles. He continued, however, to pass blood, and mixed with it gelatinous-looking pieces, until he died; and it was beyond a doubt a case of cholera.

No. 5.

A TABLE showing some important Particulars in connexion with Bloody Evacuations.

Name.	Age.	Taken ill.	Date and Hour of passing Blood and Bloody Evacuations.	How many hours after seizure before passing Blood.	How long did the Patients live after passing Blood.
1. Ann Juby	58	Oct. 7, 5 p.m.	Oct. 8, 10 p.m., purged, evacuations yellowish white, with a shade of pink. Oct. 9, noon, evacuation biley; at 3 p.m., evacuations were like beef tea thickened with flour. Oct. 10, 7.30 a.m., evacuation bile-stained; 8 p.m., evacuation nearly all blood.	22 hours; doubtful Undoubted, 22 hours	About 2 days 9 hours after commencing evacuation; doubtful; about 5 hours after undoubted bloody evacuation.
2 Mary Flinn	62	Oct. 4, 3 a.m.	Oct. 4, 11 p.m., purged, bloody	20 hours	Never found out while alive.
3. Charles Wood	51	Sept. 9, 7 a.m.	Sept. 10, 1 a.m., purged, jelly, with a tinge of blood.	18 hours	12 hours.
4. Arthur Grant	53	Sept. 25, 10 p.m.	Sept. 26, 7.45 p.m., bloody evacuations, pulseless, respiration 36, smell very offensive.	22 hours	About 2 hours.
5. Ann Nichols	67	Sept. 19, 6 a.m.	Sept. 20, 8.30 a.m., large yellowish gelatinous evacuation on sheet, mixed with blood, looks livid, lips livid, respiration laboured; 1 p.m., almost pulseless.	26 hours	12½ hours.
6. Henry Hollerman	30	Sept. 28, 9 a.m.	Sept. 30, 6 a.m., bloody evacuation	45 hours	25½ hours.
7. Sarah Ann Dobie	64	Aug. 31, 8 a.m.	Sept. 1, 12.30 midnight, bloody evacuation	16½ hours	
8. Lawson Francis	54	Sept. 13, 5 p.m.	Sept. 15, 2 a.m., bloody evacuation	33 hours	6 hours.
9. Mary Smith	40	Oct. 9, 3 a.m.	Sept. 13, 1 midnight, thin gruel-like evacuation, tinged pink.	-	19 hours.
10. Robert Clark	37	Sept. 22, 5 p.m.	Sept. 23, 4.15 p.m., passed four bloody evacuations since 12.30 noon.	21 hours	9 hours.
11. Joanna Phillips	27	Sept. 11, 2 p.m.	Sept. 12, 3 p.m., purged like chocolate and cream; 4 p.m., slightly tinged with blood; 6 p.m., evacuation like pure blood.	26 hours	8 hours.
12. Sophia Finch	37	Sept. 29, 5 a.m.	Sept. 30, 11 a.m., yellowish gelatinous evacuation, tinged with pink; 1 noon, red dirty thickish water, smell very offensive; 5 p.m., pure blood.	30 hours from the beginning of it.	22 hours 45 minutes.
13. Mary Adams	17	Sept. 16, 10 p.m.	Sept. 18, 4 a.m., one bloody evacuation	30 hours	4 hours 15 minutes.
14. Hannah Bennett	54	Sept. 17, 2.30 p.m.	Sept. 18, 5 a.m., four bloody evacuations	15½ hours	

Name.	Age.	Taken ill.	Date and Hour of passing Blood and Bloody Evacuations.	How many hours after seizure before passing Blood.	How long did the Patients live after passing Blood.
15. Margaret Denty - - -	57	Aug. 31, 1 a.m. - -	Sept. 1, 4.30 a.m., evacuation clear blood; 3 p.m., also. Sept. 2, the evacuation again biley-looking. „ 3, 4, and 5, ditto ditto.	$28\frac{1}{2}$ hours - -	6 days afterwards.
16. Cornelius Leonard - - -	50	Sept. 8, 7 p.m. - -	Sept. 10, 8.45 a.m. - - - - -	37 hours 45 minutes -	19 hours.
17. John Hockley Ford - -	8	Sept. 7, 7 a.m. - -	Sept. 8, 9.30 a.m., evacuation bloody; afterwards became thin, yellow, and watery.	$26\frac{1}{2}$ hours - -	
18. Bridget Boyle - - -	50	Sept. 10, 3 p.m. - -	Sept. 11, 3 a.m., pinkish red evaculation; 6 a.m., passed a large quantity of blood.	14 hours - -	2 hours 45 minutes.
19. Emma Mills - - -	39	Sept. 24, 1 mid-day -	Sept. 25, 10.40 p.m., evacuation dark fluid like blood. Sept. 26, 7 a.m., bloody evacuation in bed.	About 34 to 43 hours -	Cannot say when it first began.
20. Thomas Walters - - -	58	Sept. 9, in the afternoon (for calculation say 5 p.m.).	Sept. 10, 10.30 p.m., dark red, apparently bloody, respiration 36, seems very restless, eyes much sunken.	About 29 hours -	
21. Maria Sawyer - - -	5	Aug. 30, 6 a.m. - -	Sept. 6, 1.40 p.m., purged twice, blood - -	7 days - - -	Lived 12 hours afterwards.
22. Sarah Sands - - - -	61	Aug. 29, 12 p.m. (? doubtful if 12 p.m. noon or midnight).	Aug. 30, 2 a.m., purged blood twice (is not stated properly).	- - - -	10 hours.
23. Mary Willcox - - -	48	Sept. 27, 8 p.m. - -	Sept. 29, 6 p.m., purged, pea soup; 11 p.m., purged, evacuation looks like blood; has had cinnamon-coloured motions. Sept. 30, 10 a.m., looks like pea soup mixed with blood.	51 hours - -	26 hours.
24. Ann Harris - - -	36	Oct. 6, 1 a.m. - -	Oct. 7, 12 midnight, first flux of blood - - Oct. 8, 2.30 a.m., second bloody evacuation, pulseless.	About 24 hours -	12 hours.
25. Jane Hogg - - - -	29	Sept. 19, 3.30 p.m. - -	Oct. 20, 4 p.m., purged, looks like blood; 7 p.m., evacuation looks like milk tinged with blood. Oct. 23, passed a yellow stool.	24 hours 30 minutes -	Not quite 4 days.
26. Jane Jenkins -	61	Sept. 1, midnight, purged „ 2 afternoon, vomiting, purged, cramp.	Sept. 3, 3.15 p.m., purged, looks like blood -	About 24 hours; the exact hour cannot be fixed.	4 hours 45 minutes.
27. Ann Hughes - - -	67	Oct. 10, noon - -	Oct. 12, 11 a.m., evacuation like blood - -	About 48 hours -	22 hours.

Appendix.

No. 8. *On the Clinical Characters of Cholera*, 1866, *by Dr. Sutton.*

One patient passed on the 8th October a cinnamon-coloured stool; at 10 p.m. a yellowish-white evacuation, with a shade of pink. On the 9th, at noon, a greenish-yellow, bile-stained, but fluid stool. At 3 p.m. the evacuation looked like beef tea thickened with flour. On the 10th, at 7.30 a.m., she again passed a biley-like stool; at 8 p.m. the evacuation was nearly all blood; and she died 22 hours afterwards.

I propose next to inquire what evidence there is to show that patients dying with bloody evacuations are in reaction; what facts were there to show that such patients died in imperfect reaction?

First. The symptoms during life. The natural colour, the greasy, perspiring skin, the warm, furred tongue, indicate reaction; the absence of pulse, the cold, livid, sodden hands, and wakefulness, point to collapse. We have, therefore, symptoms showing some reaction, but not such as indicate complete reaction.

Secondly. The post-mortem appearances of those dying of cholera with bloody evacuations teach that the lungs may have their normal appearance, or perhaps congested, or pale looking, not unlike what is seen in collapse. The heart contains a fair quantity of blood in the left side, quite as much as is seen after death from any ordinary cause. The intestines are not packed together, as is usually seen in collapse; their contents are in the jejunum either a thick red-looking fluid, and "rice-water" fluid in the ileum; or in other cases the small intestine contains in its upper part bile-stained mucus, in its lower part bloody-looking fluid; in another case the duodenum and jejunum contained a dark yellow bile-coloured fluid; the mucous membrane of this part of the intestine bile-stained, and at the same time in the ileum there is a bloody-looking fluid, and the mucous membrane of the ileum be congested.

There is, therefore, in the morbid anatomy of such cases the same evidence as in the symptoms during life—evidence of reaction, but not of complete reaction.

The morbid appearances on the bodies of patients who have died of cholera with bloody evacuations.

I am here anxious to draw attention to the morbid appearances after death from cholera with bloody evacuations. As this proved to be such a very fatal form of the disease, it will probably be considered advisable to investigate this subject as far as possible; and especially any points tending to throw light on its pathology. The following cases may be therefore not uninteresting:—

Henry C., aged 40, admitted August 6th, died August 11th, 1866. Cholera.

Lungs weigh 28 ozs. Anterior portions were pale, and contained little blood; posterior portions were a darker colour; texture was not particularly soft. By pressure a quantity of frothy blood was squeezed out of the posterior parts near the bases. Bronchial tubes were congested. Pulmonary artery contained fluid blood.

Heart weighs $10\frac{1}{2}$ ozs. Surface posteriorly ecchymosed. Right side not particularly distended. It contained fluid blood and a moderate-sized discoloured clot. Left ventricle not contracted, and contained a partially decolourized clot of moderate size extending into the aortic orifice; muscular tissue healthy.

Liver, 3lb. 9oz., very much congested. Blood in the hepatic veins thick and black. Gall bladder full of bile.

Kidneys, 9 ozs. Apparently healthy.

Stomach. In parts much congested.

Duodenum. Glands not enlarged. Mucous membrane not congested. Contents, a greenish yellow, thick gelatinous substance.

Jejunum. Mucous surface healthy. Contents, the same as in the duodenum, evidently bile-stained.

Ileum. In the greater part the mucous membrane was not congested, and looked healthy, and Peyer's patches were not enlarged and of a natural colour. About a quarter of a yard from the cœcum, the mucous membrane was very intensely congested. A very deep port-wine colour, surface very granular. A Peyer's patch in this part also much congested. Another patch, great congestion around it; the patch itself not affected. Solitary glands also enlarged.

The ileum contained a reddish drab thick opaque fluid. Cœcum apparently healthy. Contents the same as in the ileum.

Large intestine. Ascending colon, mucous membrane very much congested, a deep port-wine colour and granular. In this part of the colon there are a number of irregular shaped ulcers; some circular, others elongated and running transversely across the intestine. The edges of the ulcers are markedly raised and uneven, as if of recent date, and in a process of extension. The faces of the ulcers are of a reddish grey colour.

Spleen weighs 3 oz. Rather pale.

Bladder contracted, contained a little urine.

It was by no means the rule to find ulceration in the intestines of patients who had died with bloody evacuations.

In some bodies there was much less congestion of the mucous membrane to account for the blood in the stools than in others. In support of this, I may briefly mention the appearance of the intestines of a patient aged 60, who died of cholera, apparently in very early reaction, and 18 hours after marked symptoms set in. The record is as follows:

The intestines are not packed together in the abdomen as is usually seen in death during collapse. Stomach contains rice water, its mucous membrane is pale. Mucous membrane of the duodenum is rather pale, with here and there a patch of congestion, not very large. Jejunum is congested, the mucous membrane is uniformly red, as if blood-stained. This is the case more or less throughout, but most marked in the upper part. The mucous membrane of the ileum is of a natural colour, excepting two or three patches of congestion the size of a sixpence. Cœcum healthy, excepting a few small spots of ecchymosis. Large intestine, mucous membrane pale. Contents of the jejunum a thick reddish gelatinous substance; contents of the ileum in its lower part more like rice water.

With the object of still further illustrating this subject, I have included in a table (p. 378–9) four more cases. In the first and second cases it may be noticed that the amount of congestion was very much less than in the other two.

Stage of reaction.

The reaction stage of cholera is considered by many physicians not to be an essential part of the disease, the cold stage being the essential part.

This view, however, has been by others disputed, and the algide stage has been regarded as the initiatory part of the disease, and likened to the cold stage of ague.

Against the latter view experience has shown that the "cold stage" is more or less constantly present, while the reaction stage is in some cases absent, or so slightly marked as not to be recognized.

The cases admitted into the Cholera Hospital clearly showed that the reaction stage was long or short, accordingly as the cold stage was intensely or feebly marked.

It was noticed that a patient might have a very mild cholera process, and yet have a sharp but very short reaction. In illustration of this I could mention one case, and others of a somewhat similar kind could

A TABLE showing the Post-mortem Appearances

Sex.	Age.	External Appearances.	Pleura.	Lungs.	Weight of Lungs.	Heart.	Weight of Heart.	Liver.	Weight of Liver.
					oz.		oz.		lb. oz.
M.	36	Rigor mortis well marked in lower extremities.	Healthy -	Right - - - - Both collapsed. Left - - - -	12 11	A few spots of ecchymosis posteriorly; right side much distended and contained blood; a small decolourized clot left ventricle; aorta contained some fluid blood.	10	- - -	3 2
M.	36	Rigor mortis well marked in lower extremities; not in the upper.	—	Right - - - - Not collapsed; on section a dark red colour, evidently very much congested; anterior portion third not so dark in colour as the posterior two thirds; on pressure a quantity of frothy fluid is squeezed out; the lungs were rather œdematous; the tissue rather but not very soft; bronchial tubes contained mucus; pulmonary artery contained fluid blood. Left - - - -	23 20	Ecchymosis on posterior surface of heart and base, running along the course of the vessels only. Left ventricle flaccid; contained fluid blood; no clot; slight ecchymosis on surface of.	12½	Healthy -	4 2
M.	60	Rather wasted; rigor mortis marked.	Both were adherent at upper lobes.	Lying flat, as if collapsed. Right - - - - Emphysematous throughout; posterior halves congested; exudes dark frothy blood; readily breaks down; anterior portions were pale, but on exposure to the air became scarlet, also tough and dry; bronchial tubes congested. Left - - - - Same as right.	17 13	Left ventricle contracted; contains a small quantity of blood and a partially decolourized clot; the valves healthy; left auricle healthy; right ventricle cavity dilated; pulmonary artery contained blood.	12	Apparently healthy; hepatic veins contained thick black blood.	2 7
M.	31	Rigor mortis well marked.	Healthy -	Right - - - - Congested at apex; mottled with congestion everywhere; the greater part œdematous; contained pale frothy fluid; broke down under the finger; bronchial tubes congested. Left - - - - Mostly congested at upper lobe and posteriorly.	16 11	A few spots of ecchymosis on the surface of the heart; left ventricle contracted, and contained a little fluid black blood and a small black clot; valves healthy; right ventricle contained a large black clot.	10	Much congested.	2 11

after Death from Cholera with Bloody Evacuations.

Gall bladder. Bile.	Spleen.	Weight of Spleen.	Kidneys.	Weight of Kidneys.	Intestine.	Contents of Intestine.	Stomach.	Contents of Bladder.
		oz.		oz.				
Full of bile.	Rather soft.	7	Capsules adherent.	8	Duodenum at upper third bile-stained; the jejunum in parts were very pale; solitary glands in ileum enlarged; one or two patches of congestion.	Duodenum contains dark yellow fluid, watery ileum; a bloody-looking fluid.	Congested at the œsophageal end.	A little urine.
Full of dark-green bile.	Soft; healthy.	4	Cortical portions of a pale red colour; tissue healthy.	9	Mucous membrane pale throughout; no congestion anywhere; in some parts spots of a red colour, as if ecchymosis, not like ordinary congestion.	No appearance of bile anywhere; in the ileum a reddish-white turbid fluid.	—	—
Distended with thin bile.	Firm and pale.	2	Surface granular; cortical portion pale; medullary portion congested.	9½	Mucous membrane of a dark claret colour; duodenum especially congested; cecum congested; solitary glands enlarged.	Contained bloody fluid.	Contained greenish thick fluid; mucous membrane somewhat congested.	Contained 5 ounces of urine.
Full of bile.	Rather pale.	2½	Deeply congested throughout.	7½	Mucous membrane of small intestine was congested in patches; mesenteric glands rather enlarged; solitary glands enlarged in cœcum and ileum.	Dark salmon-coloured fluid.	Not congested; filled with rice-water fluid.	Empty and contracted.

TABLE showing the Total Duration of Vomiting, Purging, and of Reaction; and the Result of the

No.	Age.	Sex.	If any severe Algide Symptoms.	If any severe Algide Symptoms.	Pulse.	Respiration.	Duration of Purging.
1	10	F.	Yes - -	- -	Pulse just perceptible.	Oct. 9, R. 20 - - „ 10 „ 40 „ 11 „ 48	3 days - -
2	30	M.	Severe - -	- - -	Pulseless -	Sept. 2, R. 32 - „ 3 „ 32 „ 4 „ 28 „ 5 „ 32	3 days - -
3	38	M.	Yes - -	- - -	Pulse just perceptible.	Respiration 40 - -	2 days - -
4	54	F.	Yes - -	- - -	Pulse exceedingly feeble.	Sept. 14, R. 36, at 7 p.m. „ „ 44, 11.44 p.m.	15 hours, B.-
5	5	F.	Yes - -	- - -	Pulseless -	- - - -	None - -
6	32	F.	Yes - -	- - -	Pulseless -	Sept. 1, R. 28 - - „ 2 „ 40 „ 3 „ 28	No purging -
7	14	F.	Yes - -	- - -	Pulseless -	Respiration 32 - -	2 dys. 9 hrs. purged 6 times.
8	40	M.	Yes - -	- - -	Pulseless -	Sept. 9, R. 40 - - „ 10 „ 48	32 hours -
9	20	F.	- - -	No - -	Pulse distinct -	Respiration 28 - -	About 3 days
10	41	F.	- - -	No - -	Pulse distinct -	Respiration 20 - -	64 hours -
11	57	F.	Yes - -	- - -	Pulse exceedingly feeble.	Respiration 32 - -	2 days - -
12	13	M.	- - -	No - -	Pulse very small.	- - - -	7 days - -
13	40	F.	Yes - -	- - -	- - -	Respiration 32 - -	8 days - -
14	39	F.	Yes - -	- - -	Pulse only just perceptible.	Oct. 6, 2 p.m., R. 32 - „ „ 4.30 p.m., R. 60 „ „ 11.30 p.m., R. 37 „ 7, R. 28 „ 8, R. 19	48 hours no purging; purged 3 days after.
15	42	F.	Not severe -	- - -	Pulse feeble, tongue cold.	Respiration 28 - -	48 hours
16	58	F.	Yes severe -	- - -	Pulseless -	Respiration 24 - -	48 hours

the Degree of Collapse, State of Pulse, of Respiration, and Treatment ; Case, if fatal or not.

Duration of Vomiting.	Duration of Reaction.	How long after Admission before passing Urine.	Amount of Stimulants.	Treatment.	Application.	Result, Died or Recovered.
3 days - -	58½ hours -	46 hours - -	Moderate -	Mist. ammon. et serpentariæ.	Mustard, hot.	Died.
Very little vomiting.	3½ days - -	Passed none in hospital, viz., 4 days 12 hours.	Moderate -	Mist. ammon. co. -	Hot -	Died.
2 days - -	Imperfect reaction.	Passed none -	Moderate -	Mist. ammon.; mist.	Hot -	Died.
2 hours - -	Imperfect -	Passed none -	Moderate -	Mist. ammon.; saline transfusion.	Hot -	Died.
2½ days -	6 days - -	Doubtful -	- - -	Mist. choler. No. 3	Hot -	Recovered.
8 days - -	7 days - -	44 hours, a small quantity; 4th day drew off 4 pints.	Moderate -	Mist. cinchonæ in reaction; chloroform; opium.	Hot -	Recovered.
6 days, more or less.	12 days - -	18 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
Very little -	- - -	Passed none, 31 hours in hospital.	- - -	Mist. ammon.	Hot -	Died.
1 to 2 days -	26 to 48 hours -	24 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
2 days - -	2 days - -	32 hours - -	Moderate -	Mist. ammon., 3 h.	Hot -	Recovered.
A little first day, scarce any afterwards.	8 days - -	6 days 10 hours	Moderate -	Mist. ammon., 3 h.	Hot -	Died.
5 days, more or less.	7 days - -	22 hours - -	- - -	Mist. choler. No. 3; Mist. cinchonæ in reaction.	- -	Recovered.
7 days - -	7 days - -	6 days - -	Moderate -	Mist. ammon., 3 h.	- -	Died.
48 hours - -	12 days - -	5 days - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
48 hours - -	3 days - -	32 hours - -	Moderate -	Mist. ammon., 3 h.	Hot -	Recovered.
Never vomited a great deal; a little and occasionally for 3 days.	64 hours - -	Not passed any while in hospital, viz., for 73 hours.	Moderate -	Mist. choler. No. 3, 3 h.	- -	Died.

TABLE showing the Total Duration of Vomiting,

No.	Age.	Sex.	If any severe Algide Symptoms.	If any severe Algide Symptoms.	Pulse.	Respiration.	Duration of Purging.
17	23	F.	-	No	Pulse distinct	Oct. 29, R. 36 „ 30 „ 24	4 days, very frequent.
18	43	F.	Yes	-	Pulseless	Respiration 28	12 days
19	55	M	Severe	-	Pulse very small and feeble.	Respiration 22	First 20 days no purging; the last 8 or 9 days purged several times.
20	29	F.	Yes	-	Pulse scarcely perceptible.	Respiration 40	3 days
21	6	F.	Severe	-	Pulseless	Oct. 13, R. 40 „ 14 „ 36 „ 15 „ 24 „ 17 „ 22 „ 18 „ 22 „ 19 „ 36 „ 20 „ 40 „ 21 „ 48	More or less for 8 days.
22	38	M.	Yes	-	Pulse very feeble; tongue cold.	-	6 days
23	5	F.	Yes	-	Pulseless	Respiration 28	6 days
24	29	F.	Yes	-	Pulseless	Respiration 30	2 days
25	45	M.	-	No	Pulse distinct	-	No purging
26	55	M.	-	Marked, but not severely.	Pulse just perceptible.	Respiration 24	1 day
27	33	M.	-	Not marked.	Pulse distinct	-	2 days
28	18	F.	Collapse	-	Pulse very feeble.	Aug. 27, R. 36 „ „ 48 „ 28 „ 38 „ 29 „ 28	About 3 days
29	22	F.	Collapse not extreme.	-	-	-	About 1 day; no purging for 3 to 4 days, then purged 6 days.
30	48	F.	Collapse.	-	Almost pulseless; tongue cold.	Respiration 24	Purged little
31	37	F.	-	No	Pulse exceedingly feeble.	-	Purged the first 2 days, not many times.
32	43	F.	Yes	-	Pulse exceedingly feeble.	Sept. 24, R. 28 „ „ 45 „ „ 3 For seven days Respiration was between 20 and 30.	5 days

Purging, and of Reaction, &c.—*continued.*

Duration of Vomiting.	Duration of Reaction.	How long after Admission before passing Urine.	Amount of Stimulants.	Treatment.	Application.	Result, Died or Recovered.
Very much 3 days, and violently so.	7 days - -	40 hours -	- - -	Mist. choler. No. 3, 3 h.	- -	Died.
No vomiting -	17 days - -	3 days 14 hours	Moderate -	Mist. ammon., 3 h., wrapped in hot wet blankets.	Hot -	Recovered.
Scarcely any vomiting after admission.	13 days - -	46 hours - -	Moderate -	Aquæ menthæ, ℥j 3 h.; mist. ammon. et serpent., 3 h. In reaction, Sp. ether. nit. ʒss. aquæ ℥j 3 h.; mist. quinæ.	Wrapped in hot wet blankets.	Died.
2 to 3 days -	4 days - -	2 days 13 hours	Moderate -	Mist. ammon.; mist. tereb., ♏xv. ā ā for a dose, 3 h.	Hot -	Died.
No vomiting -	8 days - -	3 days 5 hours	Moderate -	Mist. ammon. -	Hot -	Died.
4 days more or less.	7 to 8 days -	4 days - -	Moderate -	Mist. ammon. co.; mist. ammon. et serpent.	Hot -	Recovered.
48 hours - -	5 days - -	4 days 8 hours	Moderate -	Mist. ammon. In reaction, Sept. 16, mist. cinchonæ acid.	Hot -	Died.
2 days - -	68 hours - -	Passed none while in hospital, 3 days 13 hours.	- - -	Mist. choler. No. 3, 3 h.	Hot -	Died.
24 hours - -	24 to 36 hours -	About 31 hours	Moderate -	Mist. ammon. co., 3 h.	Hot -	Recovered.
10 hours - -	3 days - -	43 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
1 day - -	2 to 3 days -	About 34 hours	Moderate -	Mist. ammon. co. -	Hot -	Recovered.
About 3 days -	11 days - -	Doubtful -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
7 days - -	Excessive vomiting first 2 or 3 days; 15 days 12 hours.	4 days 8 hours	Moderate -	Mist. ammon.; mist. choler. in reaction; Oct. 5, mist. cretæ co.	Hot -	Died.
Vomited not very much.	3 days - -	25 hours - -	Moderate -	Mist. ammon.;	Hot -	Recovered.
Vomited the first 2 days.	3 days -	48 hours - -	Moderate -	Mist. ammon. 3 h.	Hot -	Recovered.
3 days.	6 days - -	None while in hospital.	Moderate -	Aquæ menthæ, ℥j., 3 h.; Mist. ammon. et serpent.	Hot -	Died.

TABLE showing the Total Duration of

No.	Age.	Sex.	If any severe Algide Symptoms.	If any severe Algide Symptoms.	Pulse.	Respiration.	Duration of Purging.
33	49	F.	Yes - -	- - -	Pulseless for 12 hours.	Sept. 9, 8 p.m., R. 64 - „ „ 10 p.m., R. 52 „ „ 10.45 p.m., R. 57 „ 10, 6 a.m., R. 60 „ „ 7 a.m., R. 44 „ „ 6.30 p.m., R. 48 „ 11, 6 a.m., R. 36 „ „ 6 p.m., R. 40 „ 12, R. 40 „ 13, died.	3 dys. 18 hrs.
34	13	F.	- - -	No - -	Pulse very distinct.	Respiration 24 - -	3 days - -
35	$7\frac{1}{2}$	M.	Yes, but not severe.	- - -	Almost pulseless.	- - - -	Purged only twice.
36	$2\frac{7}{12}$	M.	Yes - -	- - -	Pulseless -	- - - -	10 days, more or less.
37	58	F.	- - -	No - -	Pulse distinct -	- - - -	62 hours -
38	adult	F.	- - -	Not severe -	Pulse distinct, but very feeble.	- - - -	Frequently for a few hours.
39	55	F.	Mild attack -	- - -	Pulse distinct, but feeble.	Respiration 24 - -	2 days - -
40	23	M.	Severe - -	- - -	Almost pulseless.	Resp. 24, not laboured until shortly before death.	4 days - -
41	39	M.	Not severe -	- - -	Never lost his pulse.	Respiration 24 - -	Not any purging for the first 22 hours.
42	25	F.	Not severe -	- - -	Pulse distinct -	- - - -	68 hours -
43	52	F.	Mild case -	- - -	Pulse distinct -	- - - -	20 hours -
44	32	F.	Mild case -	- - -	Pulse distinct -	- - - -	14 hours -
45	52	M.	Severe - -	- - -	Pulse exceedingly feeble.	Respiration 28 - -	14 hours -
46	39	F.	Yes - -	- - -	Pulse only just perceptible.	Oct. 6, 2 p.m., R. 32 „ „ 4.30 p.m., R. 60 „ „ 11.30 p.m., R. 37 „ 7, R. 28 „ 8, R. 19 „ 14, R. 24	No purging 3 days; last 5 days purging.
47	43	M.	Yes - -	- - -	Pulseless -	Respiration 36 - -	3 days - -
48	15	F.	Not well marked.	- - -	Pulse distinct	Respiration 20 - -	$4\frac{1}{2}$ days -
49	61	M.	Not severe -	- - -	Pulse distinct	Oct. 5, 9.30, Resp. 24 - „ 8 „ 36 -	3 days - -
50	4	M.	- - -	No - -	Pulse very feeble.	Very distinct - -	12 hours -
51	11	M.	- - -	None - -	Pulse distinct	Respiration 20 - -	About 2 days

Vomiting, Purging, and of Reaction—*continued.*

Duration of Vomiting.	Duration of Reaction.	How long after Admission before passing Urine.	Amount of Stimulants.	Treatment.	Application.	Results, Died or Recovered.
24 hours - -	60 hours - -	None passed in hospital, 3 days 18 hours.	Moderate -	Mist. ammon. co., 3 h.	Hot -	Died.
2 days - -	3 days - -	3 days -	Moderate -	Mist. ammon. -	Hot -	Recovered.
30 hours - -	6 days - -	25 hours - -	Moderate -	Ol. ricini ʒij, 2 h.; the oil vomited; did not operate.	Hot -	Recovered.
Vomited very little.	13 days - -	3 days - -	Moderate -	Mist. ammon. co., 3 h.; mist. cinchonæ, 2 h.	Hot -	Recovered.
- - -	3 days - -	50 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
2 hours - -	Perfect reaction 2 days.	18 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovering.
36 hours - -	3 days - -	3 days ? - -	Moderate -	Mist. choler. No. 3	Hot -	Recovering.
4 days 1 hour -	6 days - -	2 days 3 hours	Moderate -	Aquæ menthæ, 3 h.; Mist. ammon.	Hot -	Died.
20 hours - -	3 days - -	43 hours - -	Moderate -	Mist. choler. No. 3, 3 h.	Hot -	Recovered.
15 hours - -	3 days - -	Passed urine soon after admission.	Moderate -	Mist. ammon., 3 h.	Hot -	Recovered.
Vomited very little in hospital.	12 hours - -	10 hours 40 minutes.	Moderate -	Mist. ammon., 3 h.	Hot -	Recovering.
- - -	2 days - -	10 hours - -	- - -	Mist. choler. No. 3, 3 h.	Hot -	Recovering.
5 days - -	7 days - -	Doubtful; about 5 days.	- - -	Wrapped in hot blankets, aquæ menthæ, 3 h.	- -	Died.
Vomited 48 hours	12 days - -	5 days - -	Moderate -	Mist. choler. No. 3 in reaction; Mist. cinchonæ; Mist. quinæ.	Hot -	Died.
3 days - -	- - -	38 hours - -	Moderate -	Mist. choler. No. 3. 3 h.	- -	Died.
About 3 days -	About 4 days -	54 hours - -	Moderate -	Mist. choler. No. 3, every 3 h.	- -	Cured.
3 days - -	About 3 days -	35 hours - -	Moderate -	Mist. acid sulph. ʒiv.; Oct. 7, pil. cupri sulph.; Tr. digitalis ♏x. every hour.	- -	Died Oct. 11, 8 a.m.
Very little while in hospital.	About 40 hours	None stated.	Moderate -	Aquæ menthæ.	—	—
About 32 hours	2 days - -	About 34 hours after admission.	Moderate -	Mist. choler. No. 3, ʒss. 3 h.	- -	Cured.

APPENDIX.

No. 8.
On the Clinical Characters of Cholera, 1866, *by Dr. Sutton.*

be brought forward if necessary. A child about 12 years old was admitted into the Cholera Hospital for cholera. The symptoms were so slightly marked that I had considerable difficulty at first in making up my mind as to whether it was cholera or not. She had, however, rice-water looking fluid, vomiting, and purging, but very little of either. She passed into reaction, and on her cheeks appeared a bright red blush; her skin became hot; she was very drowsy and heavy; in this condition she remained about 24 hours, and then appeared to get well all of a sudden. It was very instructive to notice, how quickly children about 10 to 14 years old with algide symptoms passed through the reaction, and became convalescent, and that in one-third the time that an adult would take.

I have seen a lad, who on admission had well-marked algide symptoms, have in reaction a hot skin, dry, parched, glazed tongue, jerking, rapid pulse, lying in a stupor, with difficulty roused, at times screaming out that one could hear him all over the ward; and on the third day he was setting up in bed, apparently quite well.

Where the algide symptoms were very severe, the reaction was great and very protracted. Therefore the cases of cholera which had the most severe "cold stage" had the longest reaction. In support of this statement I would appeal to the table given below.

This table includes 50 cases—27 of which had undoubted and severe algide symptoms, and in 23 this class of symptoms were not well marked. I have arranged the table in such manner as to show in each case the intensity of the algide symptoms and the duration of the reaction. It also shows how many days or hours elapsed, (calculating from the hour the patient was admitted into the hospital) before urine was passed or drawn off. In severe cases I usually examined the abdomen to see if the bladder was distended, and if so the urine was drawn off.

Of the 27 cases with very severe algide symptoms only 8 recovered; of the 23 cases with no very severe algide symptoms all recovered; of the latter class of case, the characteristic symptoms of cholera were very well marked, but there was no evidence of collapse. The pulse was small, very feeble, but distinctly felt. Cramps in the legs. There was very frequent rice-water vomiting and purging; the hands were cold, livid, and shrivelled; tongue cold, lips livid.

The number of cases in which the algide symptoms were very severe - -	27	The average duration of reaction in this class of case -	7·06 days.	How long in hospital before passing urine -	3·3 days.
The number of cases in which there were no severe algide symptoms	23	The average duration of reaction in this class of case -	2·8 days.	How long in hospital before passing urine - -	1·5 days.

In estimating the duration of the stage of reaction it is necessary to bear in mind that 18 of the 27 patients died while in reaction; 7·06 days therefore is not a true calculation, as to how long a patient is likely to remain in consecutive fever, for if the patients had survived, the stage of reaction would have been longer. It is more correct therefore to calculate the duration of the reaction stage, from the cases that recovered. There were of this number 9 cases, and the average duration of the stage was 9·02 days, that is, very nearly two days longer than in the fatal cases.

Where the algide symptoms were very severe the longest duration of

reaction was 17 days ; the shortest 60 hours. In the mild cases, where the algide symptoms were not very severe, the longest duration of this stage was 7 days, and the shortest 12 hours. After what has been just stated, it will probably be considered that the reaction stage of cholera, in proportion to the severity of the "cold stage," is protracted because the "cold stage" is severe, in the same way as the stage of recovery after the 21 days of typhoid fever is protracted when the attack has been very severe.

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Remarks on the Symptoms of Cholera.

Suppression of urine.

The period during which the urine was suppressed varied according to the severity of the algide symptoms. When the algide symptoms were very severe the urine was suppressed some time ; when slightly marked there was little suppression of urine.

The above remarks are based on the facts that I have already given in the table.

In the 27 cases with severe algide symptoms, the urine was suppressed on an average 3·3 days.

In the 23 cases with no very severe symptoms, the urine was suppressed 1·5 days.

In one case, where there were severe algide symptoms, and no urine was passed, and none discovered in the bladder for six days and ten hours ; another for six days ; in two cases none for five days ; in two cases none for four days.

In the milder class of case the longest period in which no urine was passed was three days, and the shortest period was 10 hours.

The first portion of urine passed was in some cases of a natural colour or a deeper colour than natural ; in many cases the urine was pale, slightly turbid, the usual pale slightly turbid appearance of albuminous urine. After the secretion of this fluid commenced, it generally went on in some cases very actively ; that is to say, the patient passed more than the ordinary quantity of urine. In more than one case four to five pints were drawn off in 24 hours.

Patients, while in imperfect reaction, and a few hours after algide symptoms had disappeared, frequently expressed a great desire to pass urine ; they were, however, unable to do so, and on examining the abdomen, the bladder was not found distended.

It was difficult in some cases to find out when the patient passed urine for the first time, and during the early part of my experience at the Cholera Hospital, on asking if a patient who was just coming out of the cold stage had passed urine, I was often told yes, and some fluid precisely like urine was brought in evidence of the statement. It was a bright, clear, transparent amber-coloured fluid. My suspicions were aroused as to whether this was really urine, for it appeared very singular that patients should so often pass urine before they were fairly out of collapse, and this immediately after they had ceased to pass rice-water stools. The result was, on inquiry, I ascertained that the fluid that looked precisely like urine was passed from the rectum. I may now be permitted to make a few remarks on the evacuations passed by cholera patients.

The evacuations in cholera and the appearances they presented in different stages of the disease.

The first stools appeared to have been watery, and of the ordinary fæcal appearance. Next followed the rice-water evacuations ; the latter had in the beginning, in some instances, a yellowish tinge, which was lost as the purging went on. In the rice-water stools there was a quantity of gelatinous-looking matter ; in some instances this was present in large amount. As the patient was about to enter into reaction he often ceased to pass rice-water, but voided instead a bright clear amber-

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coloured fluid, exactly like urine. At other times this fluid was not clear but opaque, with lumps of jelly-like matter in it. After this, in some cases, bright emerald green coloured fluid was passed; next pea-soup coloured stools; and lastly, yellowish brown or bile-like stools.

The evacuations preceding pea-soup like stools contained a large quantity of water. After the patient entered reaction the stools soon lost their watery character, and at last looked like bile-stained mucus.

In some cases the evacuations smelt very offensively, which, in by far the majority of cases, turned out to be a very bad omen. The bloody evacuations gave out a very unpleasant smell.

It was not in every case that I had an opportunity of seeing these different changes in the stools; for some patients would, on ceasing to pass rice-water, have no evacuation until they passed bile-stained mucus. A sufficient number were, however, seen to enable me to thoroughly satisfy myself as to the different changes.

Moreover, while opening the intestines, I observed their contents to present similar appearances to which I have just described, and arranged, for the most part, in a similar order. These varieties in the appearance of the stools, however, were by no means witnessed in every intestine.

Respiration in collapse was in some cases accelerated, in others there was great distress in breathing.

Respiration was noticed to be generally accelerated during collapse; not, however, equally so in all cases. One patient having no pulse at the wrist would breathe at the rate of 25 per minute, another at 50.

As the condition of the patient grew worse the respiration increased in frequency, much as follows: on October 9th the respirations were at the rate of 20 per minute; 10th, respiration 40; on the 11th, respiration 48.

In some cases, as the reaction became established, the respiration diminished in frequency; in others the respirations remained accelerated, although not so much as during the collapse. With one patient, on the 9th, at 8 p.m., respiration was 64 per minute; at 10 p.m. 52; at 10.45 p.m. respiration 57. 10th, at 6 a.m., respiration was 60; at 7 a.m. 44; at 6.30 p.m. respiration 48. On the 11th, 6 a.m., respiration was 36; at 6 p.m. respiration 40. 12th, respiration 40. On the 13th he died.

In the table last-named other cases very much similar are recorded. See No. 20, 27, 32, and 45.

The respiration was observed to be very quick in some cases, yet the patient made no complaint of the difficulty of breathing. Others complained very much of difficulty of breathing. This was strikingly seen in a female patient, aged 23. It was a case characterized by a very frequent purging, the patient was never particularly livid, and the pulse, although very small and quick, was always distinct. The distress in the breathing was not due to the severity of the collapse, for the algide symptoms were never very marked; moreover, the difficulty in breathing continued when the patient was in undoubted reaction. This patient was admitted October 26th, at 4.30 p.m. She stated that she was quite well until about 3.30 a.m. of the day of admission, when she was seized with violent "cramps" in her stomach and with purging, afterwards was vomiting and cramps in the legs came on. There was no previous diarrhœa. On admission her pulse distinct, face and hands were warm, lips rather livid, great thirst and cramps in her legs. During the first three hours after admission the cramps continued. She vomited rice-water, her eyes were sunken and glassy, and with an "empty" expression. Her pulse was 120 and feeble; tongue was warm. At 9 p.m. she said she had great pain in her chest, and the respiration was 36 per minute and laboured. She vomited very much and retched violently. On the 27th and 28th she was in

reaction, the vomiting continued and she complained very much of tightness of the chest, and said that she could hardly breathe. On the 29th at 7 a.m. she retched violently, but did not vomit much. No purging, pulse very feeble, she looks very much exhausted; she said "My breath "is so tight," and cried, "Oh, my breath; do pray do something for "me." Turpentine was ordered to be applied to the chest, and the limbs rubbed with chloroform liniment. This great distress continued, and at 8.30 a.m. she called out loudly, "Oh, I can't get my breath," and at 9 a.m. it was recorded by the Sister in charge that the patient was relieved by the rubbing, and inclined to sleep. At 11 a.m. the pulse was distinct and very feeble; her eyes had an expression of great exhaustion; skin was warm. There was no vomiting, but she was almost continually making a noise, as if attempting to retch. She still complained very much of want of breath; she referred the distress to the pit of the stomach and lower part of the breast bone, and said "It hurts me there." Chloroform ordered to be applied to the epigastrium, and the spine to be rubbed with turpentine liniment. The chloroform liniment rubbed down the spine gave almost immediate relief, and she went to sleep. 7 p.m. she did not retch so much, and she breathed much easier. 11 p.m. complained of pain in her chest; when asked where the pain was, she referred it to the lower part of the breast bone, and said "It feels so tight." On the 29th, there was still distress in breathing, but not so much as there had been. On the 30th "it is stated she still complains of pain in her chest, and frequently draws a deep sigh." November 1st, she cried "Oh, I can't breathe," and frequently threw off the bed clothes as if in a great heat. Respiration appeared very laboured; air was heard to enter freely into the chest.

The number of respirations throughout all this distress of breathing never exceeded 28 per minute and averaged about 24. This patient died Nov. 4th. The difficulty of breathing, or rather the sense of distress in breathing, appeared in this case to co-exist with the frequent retching; yet it was not dependent on the frequent retching, for it continued after the retching had subsided.

Almost all the cases with this rapid breathing died; there were, however, three or four exceptions. In one case the respirations were 60 a minute, and this patient recovered; there were, however, in this case throughout some very curious cerebral symptoms. She suffered very much, and begged that something might be given to cause her to go to sleep, and in order to relieve her great distress chloroform was administered. The number of respirations were carefully counted before administering the chloroform and found to be 60 a minute, while under the influence of chloroform there were only 30 per minute. This patient on recovering from cholera proved to be insane.

In another case with algide symptoms, the respirations were 48 per minute, and the patient recovered after a long protracted reaction.

A severe class of case that tends to do well.

There were cases in the hospital in which the symptoms were very well marked; the patients suffered a great deal; so much was this the case, that it appeared as if those who suffered the most did the best, and strangers, non-professional persons, visiting the wards, invariably considered this class of patients the most dangerously ill; yet it was by no means the case.

In these cases there was a great deal of vomiting and purging. Patients would be noticed to vomit and retch a great deal, and then throw themselves back on the bed and cry out, "Oh dear, give me some water, I am so thirsty." They would drink greedily, and a few minutes afterwards the stomach would eject rice-water looking fluid. There was frequent and continued purging. An expression of great distress.

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Tongue was cold. Lips livid. Cramps in legs, especially severe in muscular men. Countenance and body not very livid. Temperature in the axillæ about 95 or 97. Pulse always perceptible and distinct, very small and soft, but not absent. Respiration accelerated somewhat, about 20, 25, 30 per minute. As the reaction set in the patients slept, but the latter interrupted frequently with the vomiting. Bile-stained mucous stools were passed in reaction, in some cases very many such. The reaction was short, and the patients rapidly convalesced.

In some of the cases the vomiting was excessive, far out of proportion to the purging.

A few such instances just named did after excessive vomiting and purging pass into a prolonged reaction and died, but the average rate of mortality is comparatively low.

The most fatal form of case.

In striking contrast with the above was another class of case, where many of the symptoms were almost the very opposite of those just given. There was very little purging and vomiting, and I may briefly state all the severe algide symptoms, and the signs of collapse.

Symptoms of all others that appeared to offer the best guide was the pulse. Very few indeed who were pulseless recovered. My impression is, that not so much as five per cent. of the cases who were absolutely pulseless at the wrist recovered.

Many more than this passed out of collapse and regained their pulse; and the latter became very distinct, yet the patients died in reaction.

The most fatal kind of cases were those in which bloody evacuations were present. Every one of such cases died, excepting one very doubtful case—doubtful as to whether it was really cholera at all; the patient never had any very characteristic symptoms.

How patients died while in reaction.

I have little or nothing to add to what has been already written by many excellent observers on the subject of reaction. I would here only briefly mention how some of the patients appeared to die.

Writers on cholera have stated that there are several varieties of reaction, and my experience would fully confirm that statement.

In a few, the immediate cause of death seemed due to enteritis. Patients were seen lying on their backs, with their knees drawn up, abdomen distended, face flushed a deep red even over the forehead, pain in abdomen, occasional vomiting, with a little purging, pulse very small, quick, and frequent, and no stupor.

In some death appeared to be brought about by bronchitis. I would here venture to allude to the following case:—James Dalton, aged 30, when admitted, September 1st, into Cholera Hospital, he was exceedingly livid, his pulse only just perceptible, his voice choleraic, and with other algide symptoms. On the evening of the same day he was pulseless. September 2nd, he was in decided reaction; his pulse was distinct, skin was warm, tongue was warm, and sleeping quietly; respiration 28; evacuations were of a yellow colour. September 3rd, his pulse was distinct, tongue and skin warm, purged three times, evacuations yellowish green like bile, slept a little, no vomiting; conjunctiva much congested. Sonorous rhoncus was heard over the lower part of the chest posteriorly, but no crepitation. He had a cough; he was expectorating a thick airless pus. Respiration 32. 4th, 9 a.m. Excited and talking wildly all the night; no purging, no vomiting, pulse distinct, face was flushed, expectorating the same puriform matter. This morning he appears quite conscious, and speaks rationally. 12.20 midnight. Respiration 28. Crepitation was heard over the bases of both lungs, no dullness on percussion. He again became pulseless; respiration was very laboured, 32, and he died September 5th, 9.20 p.m.

While making the post-mortem examination at the London Hospital,

I several times found after death in reaction the bronchial tubes filled with what looked like pure pus.

In some the reaction was prolonged ; the pulse remained feeble and small, colour natural ; patients not in a stupor, the opposite, but inclined to be wakeful ; vomiting very troublesome, and continued at intervals for days ; purged yellow bile-stained evacuations, and passed urine day by day. So things went on for days ; the patients did not improve ; they appeared to do so for the first three or four days, and hopes were entertained that they would recover. The purging, however, continued, and the evacuations contained a large quantity of bile ; at last the evacuations increased in size, the pulse got more and more feeble, the patients became pulseless, and died.

Some cases in which there were well-marked algide symptoms struggled safely into advanced reaction, then passed into a stupor ; they continued in this condition some days, apparently in a heavy sleep ; they could be roused to take food, and when roused they were so far conscious as to show signs of recognition, but immediately afterwards relapsed into the same semi-comatose state. This continued for a few days, during which time there was very little purging ; after a while the patient passed two or three large evacuations, and a few hours afterwards died.

One patient continued eight days in this condition of stupor. Very little purged during the whole of this time ; and during seven days not at all ; the same with the vomiting. On the eighth day (September 8) it is reported as follows :—

9 a.m. No vomiting, no purging ; she lies in the same stupor.

10 a.m. Hiccup is very troublesome. Respiration is quick. Still in the same state.

6 p.m. She lies in much the same condition.

9 p.m. Purged a large evacuation of a very dark colour.

11 p.m. Has passed a large quantity of dark brown fluid on the bed. Respiration is very laboured and hurried, 40 per minute.

Sept. 9th, 2 a.m. Next morning she died.

One patient who was admitted with well-marked algide symptoms passed into reaction, and appeared to be doing very well, when most unexpectedly she was seized with epileptiform convulsions, which continued off and on for about 24 to 36 hours, and then she died. The husband of this patient stated that she had been subject to fits some years ago, but not very lately.

A little boy, who also had well-marked algide symptoms and was pulseless, passed into reaction, and was suddenly seized with convulsions, which returned until he died. His mother stated that when an infant he was subject to fits. Many cases had convulsive seizures at the time of death, but these only occurred just before death, or in the act of dying.

Acute pneumonia appeared to be the immediate cause of death in one patient, and it is well known that it is not uncommon to find the lungs of patients who have died in reaction in the condition known as hepatization.

Remarks on the Pathology of Cholera.

I do not propose to say anything on the question of a poison in the blood being the cause of the disease, for I have no new facts illustrating this point to bring forward, and I am not able to put the old ones in any stronger light than they are at present. I therefore pass on to say a few words about the morbid changes that take place during collapse.

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During collapse the blood appears to be retained almost entirely in the venous side of the system.

After death in collapse the venous system was found to contain by far the more blood. The arterial system contained, in contrast with the venous system, scarcely any blood. During the late epidemic I made 50 post-mortem examinations and witnessed many more; my experience during such examinations led me to agree with Dr. Parkes as to the appearance of the lungs in patients who have died in collapse and not in reaction. When the symptoms indicated collapse, and where there was nothing but rice-water looking fluid in the intestine, in by far the majority of cases I found the lungs collapsed (of course when they were not adherent to the chest walls), lying back against the spine; they weighed very much less than normal, often half as light. On section they were dry and contained very little blood, and what they did was almost all found in the branches of the pulmonary arteries. It was black-looking blood thicker than normal, but not by any means so thick as some have described it; nor was it so thick but that, on accidentally puncturing the jugular vein, it escaped in such quantities that the right side of the heart was in one or two minutes completely emptied. There was, I think, no reason as regards its thickness why the blood should not have circulated through the capillaries. The anterior portions, in some cases, of the lungs were noticed to be of a grey colour, and very much paler than normal; the posterior portions and the bases were much darker in colour than the anterior portions, soft and were easily broken down. When the divided surfaces of the lungs had been exposed to the air for a few seconds, they rapidly became of a bright scarlet colour. This was so in every part of the lungs, and in no part was it more marked than in the pale anæmic looking portions. On first exposure a few scarlet looking spots were noticed amongst the pale grey looking portions; these increased in numbers, giving the surface of the lungs a pinkish grey appearance. The spots became more numerous until the whole surface was of a bright scarlet colour. In other cases the lungs were congested throughout, of a deep claret colour, but they weighed less than normal, and the intestines contained rice-water, showing death during the "cold stage." In nine cases given below the lungs were congested throughout in five, and anæmic looking in four. The right side of the heart was full of blood, the jugular veins and cava leading to the right heart were full of blood, the coronary veins were in a similar condition. The left side of the heart was contracted, and contained scarcely any blood; the veins of the pia mater were distended. As regards the kidneys, the blood was on the venous side. The stellate veins on the surface were beautifully marked; the veins on the medullary portions contained a quantity of blood, which gave that part of the kidneys a reddish blue or dark colour. The veins going from the medullary to the surface of the kidneys were very distinct; the capillaries of the kidneys were for the most part empty, as shown by the pale steel grey colour of the cortical parts. The kidneys presented, as regards the venous congestion, pretty much the same appearance as is usually seen after death from heart disease, familiarly known as "a heart kidney." There was, however, one great difference betwixt the two, and that was the cortical portions were very much paler than is usually, if ever, seen in heart disease. The veins were quite as visible as is seen after death from "contracted mitral." The liver did not show any very marked signs of hepatic congestion; once or twice I noticed something approaching the so-called "nutmeg appearance," but it was very slight, and as a rule there was no such change. Nor should I expect to find the nutmeg surface, considering the distended state of the right side of the heart exists but a very few hours or a day or two, and post-mortem experience teaches us, that chronic obstruction to

the flow of the blood through the chest is necessary for the development of the nutmeg appearance. Hence it is found well marked in heart disease, while after death from bronchitis and emphysema it is found comparatively slightly marked.

I have already mentioned that the lungs weighed very much less than normal, and so did the spleen. I have many times taken the spleen of a well-developed man, and been astonished on weighing it to find that it was not heavier than $2\frac{1}{2}$ or 3 oz. Such spleens were rather smaller, firmer and paler than natural, but proprotionately much more diminished in weight than in size. My experience here agrees with the observations of other physicians. (See Dr. Gull's report on Cholera to the Royal College of Physicians.) During the late epidemic this lightness of the spleen was, with a similar condition of the lungs, one of the most constant changes in the body. In many cases the kidneys and liver were decidedly lighter than ordinary, but not so constantly as in the case of the spleen or lungs, and when it is considered how frequently the liver and kidneys vary in weight after death from all causes, it is not so surprising that they should do so after death from cholera. After death in collapse the bladder was found invariably contracted and empty. I have very briefly recorded the appearance of the lungs, heart, spleen, and kidneys in nine cases, and I here beg to ask attention to the following particulars :—

1. A child, aged 5. Lungs, right, weighed $3\frac{1}{2}$ oz. ; left, $2\frac{1}{2}$ oz. Both deeply congested throughout. The pulmonary arteries contained fluid blood. Heart weighed $2\frac{1}{2}$ oz. Left ventricle empty, contained about a teaspoonful of fluid blood; right contained dark fluid blood and a partly decolorized clot. Spleen weighed 1 oz., pale and firm. Kidneys weighed $1\frac{1}{2}$ oz. Cortical portions were pale, medullary were congested. Intestine, mucous membrane pale throughout. In the duodenum and jejunum a pale yellowish fluid.

2. A male, aged 31. Lungs weighed $8\frac{1}{2}$ oz. each. Anterior portions of the lungs a pale greyish appearance, on exposure to the air the pale portions became of a bright scarlet colour. Posterior parts a deeper colour ; very little blood can be squeezed out of the lung. Dark fluid blood exudes from the branches of the pulmonary arteries. Heart.—Ecchymosed posteriorly. Left ventricle firmly contracted, a little fluid black looking blood, and small decolorized clots. Left auricle contained a small partially decolorized clot. Right ventricle distended. A moderate sized clot. Pulmonary artery contained fluid blood. Spleen weighed 5 oz., pale, firm. Kidneys weighed $6\frac{1}{2}$ oz. Cortical portions were pale, medullary congested. Intestine ; contents, thickish rice-water looking fluid ; some spots of congestion in the mucous membrane of the cœcum and duodenum. Bladder contained 1 oz. of urine.

3. Male, aged 71. Lungs, weight, right, $7\frac{1}{2}$ oz. ; left, $7\frac{1}{2}$ oz. Lungs emphysematous. Bronchial tubes filled with frothy-looking mucus. Lungs a dark claret colour everywhere, both congested. Heart.—Left ventricle contracted, empty. Endocardium ecchymosed. Spleen, weight not given. Kidneys, slightly granular, cortical portions were pale; medullary congested. Intestine deeply congested, contained rice-water like fluid. Bladder contracted and empty.

4. Female, aged 25. Lungs, right, $14\frac{1}{2}$ oz. ; left, 12 oz. Emphysematous, section pale in front, a deep claret colour posteriorly ; exposed to the air they rapidly became scarlet ; pulmonary tissue dry. Heart, $12\frac{1}{2}$ oz. ; ecchymoses ; left ventricle contracted, contained two or three teaspoonsful of dark fluid blood ; right ventricle very much distended with dark blood and contained a small decolorized clot ; pulmonary artery contained dark clot and fluid blood. Spleen weighed $2\frac{1}{2}$ oz. Kidneys

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weighed 7 oz. ; cortical portions pale, medullary very much darker, a pale claret colour. Intestines, contents devoid of all appearance of bile ; duodenum and jejunum congested ; ileum slightly so. Bladder contracted and empty.

5. Male, aged 8 years. Lungs, weighed, right, $3\frac{1}{2}$ oz. ; left, $2\frac{1}{2}$ oz., not collapsed, uniformly congested. Heart, weighed $1\frac{1}{2}$ oz. Left ventricle contracted and empty ; right ventricle distended, contained a clot. Spleen, $\frac{1}{2}$ oz., rather pale, otherwise healthy. Kidneys, $2\frac{1}{2}$ oz. Cortical portions pale ; medullary a claret colour. Intestine.—Contents rice-water. Mucous membrane pale throughout. Bladder contracted and empty.

6. Female, aged 9. Lungs weighed 9 oz., partially collapsed, anterior portions were pale, posterior two-thirds a much deeper colour. Heart, right ventrcle, distended with blood, and a good sized decolorized clot ; left ventricle was contracted, but not firmly so, it contained a partially decolorized clot and a little fluid blood. Spleen, weight not given. Kidneys cortical portions pale, medullary pale claret colour. Intestines, a little congestion in Peyer's patches, mucous membrane of a pale healthy colour throughout; contents rice-water throughout. Bladder contracted and empty.

7. Male, aged 40. Lungs, right, 11 oz.; left, 9 oz. Anterior portions pale, posterior much deeper colour. Lungs were not collapsed. Heart, $7\frac{1}{2}$ oz. Left ventricle contracted ; right ventricle distended and contains fluid blood. Spleen, $3\frac{1}{2}$ oz. Kidneys, 7 oz. Liver, normal. Intestine.—All the lower part of the ileum congested, mucous membrane a dark red colour and granular ; contents, rice-water. Bladder, 1 drachm of urine.

8. Female, aged 26. Lungs 11 oz. (one or the two, the report does not say), congested throughout. Heart, $7\frac{1}{2}$ oz.; left ventricle contracted, but not firmly so, and contains a little fluid blood ; right ventricle very much distended, fluid blood and a partially decolorized clot. Spleen $3\frac{1}{2}$ oz. Kidneys, 7 oz.; cortical portions pale; medullary congested. Intestine, mucous membrane pale; contains rice-water looking fluid throughout. Bladder contracted and empty.

9. A child, aged 5. Lungs, right, weighed 4 oz.; left do. $4\frac{1}{2}$ oz. Lungs collapsed, right œdematous ; in their posterior and lower parts, congested, and at the bases. Nowhere was the lung remarkably pale ; left lung was similar to the right but more œdematous. Heart : right auricle very much distended and contained a clot ; right ventricle contained a good sized decolorized clot ; left ventricle was contracted and contained about a drachm of dark blood. Spleen weighed $1\frac{1}{2}$ oz. Kidneys weighed 2 oz. ; medullary portions not much congested. Intestine, contents rice-water, mucous membrane was pale throughout. Bladder was empty.

In about half the number of cases the blood was not arrested in the minute branches of the pulmonary artery, for the lungs were of a very dark red colour; evidently showing that the blood had penetrated into the capillaries, and, judging from the very dark colour of these organs, the blood had not been properly aerated.

Dr. Johnson thinks the dark red or congested appearance of the lung may be produced after death. He considers the spasm in the pulmonary arteries may relax, and then the blood, by force of gravity and by the pressure arising from a greatly distended right ventricle, may be enabled to pass from the pulmonary arteries into the pulmonary capillaries.

It is especially to be noticed that the congested lungs weighed much less than normal.

The contents of the intestine in every one of these cases clearly

showed that the patients had died during the cold stage, and most probably, therefore, in collapse.

It has been stated already that it was very common indeed to find the spleen very much diminished in weight after death in collapse. Other observers have noticed the same fact. In Dr. Gull's Report to the Royal College of Physicians, an abstract of the post-mortem appearances after death from collapse is given, and in eight cases the weights of the spleen are recorded. They respectively weighed 7 oz., $3\frac{1}{2}$ oz., 3 oz., $2\frac{1}{2}$ oz., 2 oz., 4 oz., 2 oz., and 3 oz. All the patients were adults.

In the records in the London Hospital are a number of cases besides the nine just given in which the spleen weighed very light. I would here mention the reason that I have not given a record of the post-mortem examinations of more than nine cases is, that in all the other cases, that is 41, the contents of the intestines showed the patients had died either in advanced reaction or just as they were passing into reaction.

We have not gone more extensively into the morbid appearances in the cases, as it is proposed to embody the records of the cholera post-mortems in the next number of the London Hospital Reports.

The above cases clearly show that there was much more blood in the veins than in the arteries. The latter were comparatively empty of blood. The question arises, how are we to account for this accumulation of blood on the venous side of the system? One explanation offered is, that it is due to contraction of the muscular coats of the minute pulmonary arteries.

Dr. George Johnson is the father of this theory, and it is one which is very striking and appears to explain at first sight several of the difficulties connected with collapse.

Dr. George Johnson says, "The blood contains a poison whose "irritant action upon the muscular tissue is shown by the painful cramps "which it occasions; the blood thus poisoned excites contraction of the "muscular walls of the minute pulmonary arteries, the effect of which "is to diminish, and in fatal cases entirely to arrest, the flow of blood "through the lungs."

The evidence in favour of such contraction is, according to Dr. G. Johnson, the anæmic appearance, the greatly diminished weight of the lungs, and the comparatively empty state of the arterial system in collapse. The anæmic appearance and the loss of weight of the lungs he thinks is due to the blood not being able to enter the capillaries of the lungs, owing to the contraction of the minute pulmonary arteries.

The diminished weight of the lungs is, according to Dr. Johnson, not due to loss of water.

This explanation appears to be open to objections.

In the first place, if the blood is prevented entering the pulmonary capillaries, and the volume of the blood in the body remains about normal, the organs behind the lungs, namely the liver, kidneys, and spleen ought to be congested and increased, and not diminished in weight. If there is about the normal quantity of blood in the body, and it is cut off from the arterial, it must accumulate in the venous side of the system. We know, moreover, in heart disease—for instance, in a case of so-called "contracted mitral orifice"—the blood cannot pass freely into arteries, and the veins in consequence become highly gorged, and the liver, kidneys, and spleen weigh heavier than normal. The diminished weight of the lungs in collapse might be explained on the supposition that the blood is prevented entering those organs; but how, assuming the body contains its normal weight of blood, can we explain the diminished weight of the spleen and kidneys, and of the spleen especially? If the blood is in the body and not in the lungs or

arteries, where does it get to? It cannot be in the abdominal organs, for if so they would be heavier and not lighter than normal. It may be replied in cases of obstruction through the mitral orifice the body retains its proper quantity of blood, but in collapse the volume of the blood has been very greatly diminished by discharge of the water from the system, that the lungs of patients who have died in collapse, with very little purging, have proved to be lightest; and somewhat in confirmation of the latter statement I may be allowed to mention that in the first two weeks of the epidemic, patients were brought into the London Hospital, and died after a few hours' illness, and the rate of mortality was 84 per cent., I at that time noticed the greatest loss of weight in the lungs, and in other organs. Before, however, it can be considered that the diminution in the weight of the lungs is caused by the blood not being able to enter the pulmonary arteries, and not really due to the loss of the watery and other constituents of the blood, we ought to be in possession of cases to prove that, although the loss of water and other constituents of the blood was not great, yet that the lungs weighed very much less than normal. It is not enough to say that one person was purged twenty times, and another only four times, yet one passed into collapse and had very light lungs, and the other did not.

But in Cholera how is the collapse brought about?

I have already shown that the worst cases of cholera are not those where the purging and vomiting have been going on hour by hour for 24 or more hours. It is in my mind quite clear that the cases that are the most frequently purged are not those that go into the most severe collapse; and that collapse arises not because a patient has lost 20 or more pints of fluid from the bowel and stomach in 24 hours, but because he has lost perhaps one-fourth the quantity in one, two, or three hours.

It is a well known law that if injury is suddenly inflicted on an organ the effect on the system is very much more severe than if four times as much damage had been more gradually done to the same organ. This is explained by assuming that besides the injury to the part, that there is the so-called shock to the system.

I have already, when speaking of the cholera process, shown that the cases admitted into the Cholera Hospital fully bore out what Dr. Parkes and other authorities had written, that the worst cases of cholera were not attacked with the most frequent purging. I have shown that many patients in collapse were not purged for hours. It is necessary, however, carefully to bear in mind, although they were not purged while in the hospital and under our eyes, they were very much purged previous to their admission into the hospital, and before going into collapse.

I would here venture to ask, if the cholera poison acts on the minute arteries of the lungs, and destroys the patient by so doing without any or very little purging; if we are to assume that this is the true explanation of those cases which are said to have been struck down "as if they had drunk the concentrated poison of the upas tree," how are we to explain the post-mortem appearance of the patient who was brought into the London Hospital dead, and who was struck down in a few minutes without any purging from the bowel? For, I have already said, the lungs were very œdematous, not anæmic, and did not weigh lighter than normal.

Besides the loss of weight, there is another abnormal condition of the lungs, as seen on the post-mortem table, after death from collapse of cholera, viz., the anterior two-thirds or halves of the lungs are said to look very pale, and in many cases when they are first cut into no doubt they do. Dr. Johnson thinks the blood is arrested in the pul-

monary artery by the contraction of their coats before reaching the capillaries, and this causes the pale appearance. All I would venture to remark is that this pale appearance is not peculiar to cholera; for I have seen it almost if not equally as well marked in the case of a patient who died of diphtheria, where the minute bronchial tubes were occluded by fibrinous exudation. In this case also the venous system was enormously gorged, the right side of the heart and cava greatly distended. The kidneys presented the same appearance as regards the veins as is seen in cholera. The medullary portions were of a much darker colour than the cortical. The pale surfaces of the lungs, like as in cholera, became of a bright scarlet when they had been exposed to the air for a few minutes. I have also noticed it in other cases. We are therefore compelled to assume either that the pale appearance is produced in more ways than one, or else that spasm of the pulmonary artery is not peculiar to cholera.

It is further to be considered that we have evidence of obstruction through the venous system in other forms of collapse, where there is no lightness or anæmic appearance of the lungs. The engorged state of the veins, the empty state of the arteries, and the contraction of the left ventricle, then, is not special to the collapse of cholera, for it also occurs in other forms of collapse; for instance in the collapse arising from an extensive burn.

This we have particularly noticed. A child died in the London Hospital from the effects of a burn. The post-mortem examination showed the left side of the heart very firmly contracted and empty; the right side very much distended with blood; ecchymoses on the surface of the heart posteriorly; the coronary veins very much distended; the large veins emptying themselves into the right auricle, much distended; the lungs were congested everywhere; the kidneys presented the appearance such as is seen after death of heart disease; the medullary portions highly congested, and the cortical paler than normal.

Many of the symptoms observed in the collapse of cholera may also be noticed during the cold stage of ague. The cold surface, the lividity, the accelerated respiration, the small very feeble pulse, the white tongue, are symptoms common to both. They appear to indicate that there is a diminished quantity of blood flowing through the arterial system, and that the venous system is engorged.

The evidence of venous obstruction is seen in death in collapse after a burn, and in cholera. The cause of the collapse is different in each; but I would here venture to suggest that in both the collapse may be due to the so-called "shock." The firmly contracted state of the left ventricle, and the cold state of the surface, and the small feeble pulse, might suggest that there is contraction of the small arteries throughout the body.

It has been already stated that patients in reaction died in various ways. The immediate cause of death differed. Some by epileptic convulsions, some by pneumonia, others by bronchitis, others by enteritis. And I noticed that the patients who died with bronchitis had emphysematous lungs. Those who were cut off when apparently doing well into epileptic convulsions, had been subject to fits, which would lead to the conclusion that these affections were incidental to, but not a part of the cholera. Based on the experience that practitioners so often see, that if a patient is once greatly prostrated by any disease and, begins to recover, all the evil tendencies of the tissues become developed into diseases.

The Treatment of Cholera.

When the patients were brought into the hospital and found to be suffering with cholera, the rule was to place them in bed, apply hot applications to the feet and axillæ, and to give them plenty of ice or ice water. The diet consisted, in most cases, of arrowroot for the first two or three days; to adults, half an ounce of brandy was prescribed every three hours. The brandy was given in a great many, but not in all cases. As far as medicine was concerned nearly all the cases were treated on the expectant system; half a drachm of aromatic spirits of ammonia in an ounce of water every three hours, or half an ounce of mint water; and in many cases the so-called cholera mixture, No. 3, which was made up of carbonate of magnesia, aromatic spirits of ammonia, and mint water, was given every three hours. The class of cases admitted was, as the evidence brought forward tends to show, in very many instances a severe one, and likely to put to the test any system of treatment. A few, about twelve in all, were treated with castor oil, all were very bad cases and in marked collapse when it was prescribed, and the patients died; and one case, in which there were a few algide symptoms, the patient recovered, but the oil never operated on the bowels. In three cases five grains of quinine were given every two hours; all the patients died. In no case, excepting in one or two infants, did I prescribe any astringent medicine during the cold stage of cholera; in reaction, when the patients continued to be purged for some days, astringent medicine was administered without any very marked results. In a few, saline fluid was injected into the veins; all the patients died.

The mortality averaged 54 per cent. When considering the rate of mortality it is to be borne in mind that the Cholera Hospital in Commercial Street was not opened until the severity of the epidemic had began to decline. During the early weeks of the outbreak, of the patients admitted into the London Hospital, 85 per cent. died; during the last week of August only 32 patients were admitted into the hospital and 20 recovered, and the mortality was 37 per cent.

It might be said, inasmuch as the cases were not admitted into the Cholera Hospital until the months of August, September, and October, when the mortality at the London Hospital had fallen as low as 37 per cent., that a mortality at the rate of 54 per cent. was unfavourable, and no doubt it would be so if the cases admitted into the London Hospital during these months had been equal in severity. Such, however, was not the case. The majority of the cases admitted into the London Hospital during the first weeks of the outbreak was much severer than those admitted into the Cholera Hospital, but the cases brought into the latter hospital during August, September, and October were of a worse type than those admitted into the London Hospital during the corresponding months, for the simple reason that the epidemic subsided in the parishes around the London Hospital, namely, Poplar, Stepney, Mile End, &c., but it spread into Bethnal Green and Shoreditch, Whitechapel and Hackney, from which parts cases were brought into the Cholera Hospital.

Judging from experience gained in the London Hospital, medicine seemed to have no decided influence over the disease. I, therefore, resolved when I took charge of the Choleræ Hospital to treat nearly all the cases, without any selection, on the expectant plan, and thus, by allowing the disease to run its course uninfluenced by powerful medicines, gain an insight into the natural course of the disease, and endeavour to see what class of case tends to do well, and what class tends to die.

The result showed, as I have stated, that there is a class of case which can do well without the aid of medicine. It would appear all that is necessary in such cases is a pure atmosphere, rest in bed, a good supply of ice, and careful nursing.

In opposition to the latter there was a class in which there was no such tendency to recovery, almost all the patients died, and medicine appeared to have no influence whatever. I refer to patients who passed into collapse, and especially to those who had no purging for some hours. The circulation was for the most part arrested in these cases, and there was probably no absorption going on. That a large quantity of medicine, for instance, calomel, may be administered in such cases and never go further than the stomach, I have seen evidence on the post-mortem table, for in cases where calomel in 10 grain doses had been administered every 10 minutes, I have discovered it in very large quantities in the stomach of the patient who had died in collapse.

Of this very fatal form of case I may be permitted to speak somewhat favourably of one remedy ; that is wrapping the patient up in a blanket which has been wrung out in water as hot as can be borne, the patient being allowed to remain wrapped up for half an hour or so ; then the same process repeated. This treatment had one advantage over any other that I tried, that it, to a certain extent, restored the circulation. For in the several instances patients who previous to such treatment were pulseless, after being in the hot wet blankets for an hour or so appeared decidedly better, and the pulse became perceptible and distinct. If the blankets were discontinued the pulse again disappeared, and by renewing the application, the pulse again became perceptible at the wrist.

Great care, however, is necessary in estimating the influence of any remedy over the cholera process in the cold stage, for this stage lasts but a few hours, and the apparent improvement may be credited to the remedy, whereas it may be really due to the natural course of the disease.

There was a middle class of case, where there were well-marked algide symptoms, which gradually subsided, and the patients passed into reaction; the latter stage was very protracted, but with judicious, watchful, and constant nursing, some patients recovered.

A few cases, in deep collapse and absolutely pulseless at the wrist, passed into reaction, and ultimately recovered, and that without the aid of any powerful medicine during the "cold stage."

In support of this statement I beg leave to ask attention to the following case :

This patient was in complete collapse and pulseless. The only medicine given for the first five days was a mixture known as the cholera mixture, No. 3, made of small doses of carbonate of magnesia, aromatic spirits of ammonia and mint water. No food for the first 24 hours. Only ice and half an ounce of brandy every three hours.

Martha M. Age, 39. Married. Her husband and three children died in the Cholera Hospital of cholera. She had been to the hospital to see her children, and as soon as she returned home on Oct. 6 at 2 a.m., she was taken ill with vomiting, purging, and cramps in her legs. At 7 a.m., that is, five hours after she was seized, she was brought into the hospital.

On admission her eyes were sunken. Tongue was warm ; skin was warm ; pulse was distinct, soft, and exceedingly feeble ; colour natural ; lips natural. Respiration 24. Choleraic voice. She looked very much exhausted ; vomited rice-water looking fluid ; cramps in her legs.

Mist. choler. No. 3, every 3 hs.; ice; brandy, ℥ ß, 3 hours.

Appendix.

No. 8.
On the Clinical Characters of Cholera, 1866, *by Dr. Sutton.*

8 a.m. Vomited rice-water.

8.30 a.m. Vomited rice-water, also at 9 a.m.

12.30 p.m. Cramps in her hands and feet. Lips are blue; forehead and tongue cold. Vomited a large quantity of rice-water.

1 p.m. Vomited a quantity of rice-water.

2 p.m. Respiration 32. Pulse was only just perceptible, exceedingly feeble.

4.30 p.m. Pulse can be felt, but exceedingly feeble. Respiration 60. Her hands were icy cold, livid, and sodden. She is quite conscious; asks continually for water, which she vomits immediately.

6.45 p.m. Pulse just perceptible.

11.30 p.m. She is pulseless at the wrist. Respiration 37. Hands and face exceedingly cold and clammy. Choleraic voice.

7th. 2.30 a.m. A small very feeble pulse.

3 a.m. Pulse a little stronger, but exceedingly feeble. Respiration 30. Lies on her back, dozing. Perspiration stands in drops on her forehead. Skin very cold.

5 a.m. Pulse distinct. Hands, face, and lips cold and clammy. Looks more natural. No vomiting; no purging all night.

7 a.m. Face warm. Vomited quite suddenly a quantity of mutton-broth looking fluid.

8 a.m. Respiration 28. Pulse was distinct. Skin was warmer. Asked if she might have some arrowroot, which she ate eagerly.

9 a.m. Lying in a stupor, easily roused. Lips were natural. Asks for water frequently. No vomiting since 7 a.m. No purging.

2 p.m. Vomited a large quantity of a bright yellow fluid; a flush on each cheek; skin was warm; pulse was fuller; respiration 28. Lying on her back with her knees drawn up.

4.30 p.m. Vomited green fluid.

10. p.m. No vomiting; no purging since 6 p.m.; cheeks flushed; lips red.

8th, 4 a.m. Has been sleeping for three hours; vomited yellow flakey fluid; no purging.

6 a.m. No purging; no vomiting since 4 a.m.; she has slept well.

9.30 a.m. Pulse distinct, but very feeble and soft; tongue slightly furred; face high coloured; inclined to doze, but when spoken to wakes up in a moment and opens her eyes suddenly, and in a few moments so relapses into the same drowsy state.

11 a.m. Vomited grass-green looking fluid. Mist. choler. No. 3, 3 hours; diet, arrowroot only, brandy ℥ß, 3 hours.

1.30 p.m. No purging; pulse distinct, 90; respiration 19.

9th, 1 a.m. Temperature in axilla, $95\frac{1}{5}$; pulse distinct.

4 a.m. Vomiting paler fluid with brown flakes in it; no purging; has been sleeping.

6 a.m. Has been asleep almost all night; no purging.

7 a.m. Has a flush over both cheeks; respiration 24.

9 p.m. Purged yellow evacuation, semi-solid; no vomiting.

11 p.m. Very much disposed to sleep; pulse distinct.

10th, 1 a.m. Purged an ochrey and slimy-looking evacuation.

2.30 a.m. Purged in the bed a similar coloured motion.

5 a.m. Passed urine.

10 a.m. Lies in a stupor; respiration laboured; pulse 84; colour natural.

2 p.m. Purged a large evacuation like pea soup.

5 p.m. Purged a large dark pea soup-like evacuation.

10. p.m. Purged pea soup-like stool, again at 11 p.m.

11th, 1.30 a.m. Purged as before.

6 a.m. Has slept well; at 8 a.m. again purged; no vomiting.

Decoct. Cinchonæ ℥j; acid. sulph. dil. ♏ xv., ter die. Diet, arrowroot; brandy ℥ß ter die.

12th, 1 p.m. She has passed urine; no vomiting; from 7 p.m. to 11.30 p.m. purged 5 times.

13th, 9.30 a.m. Very much inclined to doze; pulse more feeble. Mist. cretæ co. ℥j, 3 hours.

6 p.m. No purging; no vomiting.

10 p.m. Purged bile-like evacuation.

12 midnight. Purged as above.

14th, 3 a.m. Passed urine.

6 a.m. No purging since midnight, no vomiting.

8 a.m. Lies on her back in the same stupor; respiration 20, laboured.

10.30 p.m. Purged semi-solid evacuation; has passed urine several times.

15th, 1.30 a.m. She has slept three hours.

11 a.m. No vomiting, no purging; lies on her back in a state of stupor; passed urine several times.

16th, 3 a.m. Mr. Mackenzie drew off three pints of urine.

6 a.m. No purging, no vomiting; slept almost the whole night.

9.30 a.m. Mist. quinæ ℥j; ether. chlor. ♏xj, ter die.

17th, 1 a.m. Three pints of urine drawn off; during the last 24 hours only purged three times.

From this time the patient continued to improve, and about 8 days afterwards was completely convalescent.

It has been remarked already in this paper that there is a class of case that tends to do well without the aid of medicine. In such cases there is a good deal of vomiting and purging, and there is no class of patients that appear to suffer more. As it is most important that this kind of case should be recognized, the following illustration will probably be of service:—

Ann C., aged 42.—She was first taken ill at midnight 5th September, and admitted into the Cholera Hospital at 11 a.m. September 6th. The attack commenced with frequent vomiting and purging. It is not clear whether she had had any premonitory diarrhœa or not. On admission her pulse was feeble, quick, but distinct; tongue cold; skin over the abdomen warm; hands warm.

11.43 a.m. She vomited light yellowish brown watery fluid; lips livid, eyes sunken; her pulse is less distinct.

12 a.m. Vomited twice very copiously; not been purged since she came in, nor passed any urine.

1.40 p.m. Hands cramped; lips livid.

Sp. ammon. co. ʒß, aquæ ℥j, 3h.; diet, arrowroot, brandy ℥ß, 3h.

2 p.m. Purged rice-water; tongue cold; eyes very much sunken; pulse distinct; vomited once.

5.45 p.m. She has been purged altogether seven times since admission; vomited rice water; lips are very livid; pulse distinct; cramps in her legs.

10.30 p.m. Purged thick rice water looking fluid; she has vomited; cramped every now and then.

12.20 midnight. Purged rice water with jelly, also vomited.

7th, 1.30 a.m. Purged also at 2.30, and at 3.10 purged and vomited; after this she was not purged again until 8.30 a.m., when the evacuation was greenish slimy matter and not watery. She complained of pain in the abdomen; it was the kind of pain that was noticed to be generally followed by a bile-like evacuation.

Appendix.

No. 8. *On the Clinical Characters of Cholera*, 1866, *by Dr. Sutton.*

1.30 p.m. Pulse very feeble, but distinct; vomited. At 2 p.m. she vomited yellow fluid, at 3.30 p.m. also. She vomited three more times up to 12 o'clock at night; and from 10 a.m. to 12 midnight she was purged ten times. She has passed no urine since admission.

8th, 2.30 a.m. Purged. She has vomited several times.

4 a.m. Pulse quick, distinct, but very feeble. Hands cold and clammy.

6.45 a.m. Passed urine.

10 a.m. Pulse very feeble and soft. Respiration 28. Her hands are white and sodden, and somewhat shrivelled. Tongue warm, and coated. Skin is warm. No lividity. She has vomited several times.

6 p.m. Pulse much more distinct. Vomiting very troublesome.

11 p.m. Extremities cold. Pulse 80, very feeble. Respiration laboured, 28. Since 2 a.m. she has been purged seven times. As she complained much of pain in the abdomen, turpentine was applied.

9th, 6 a.m. Passed urine at 9.30 a.m. Pulse distinct. No lividity. Tongue sodden, covered with green fur. Skin warm. Complexion natural. No vomiting for two hours.

10 p.m. Pulse, 80–96. Respiration 28. She feels sick. She has during this day vomited several times, but only purged once.

10th, 10 a.m. Complains of pains in the abdomen. Colour natural. Tongue cleaner. Going on well. Purged twice. Vomited a few times.

11th. Going on well.

12th, Pil. quinæ co., ter die; middle diet.

Sent into the Convalescent Ward on the 17th, and discharged Oct. 8th.

I would here beg to acknowledge my many great obligations to the ladies known as the Plymouth Sisters, who had charge of the wards of the Cholera Hospital. Their devotion to the many poor sufferers, and their love for their fellow creatures, as shown by their self-sacrifice, needs no comment. They do not seek praise, and a grateful public has already recognized its obligations to them. On my part, I would simply state that if it had not been for the great assistance that I received from Miss Sellon and the Sisters belonging to her Order, I should not have been able to draw up this report. Their services in the wards of the hospital, quite independently of their duties in superintending the nurses, deserves the warmest acknowledgment from me. Many records of cases in my possession show clearly how much their intelligence, patience, and trustworthy help can be of the greatest service to the Physician while he is doing clinical work.

Note by Medical Officer.

[To the parts of Dr. Sutton's report which are on the theory of collapse, I append a few remarks of my own on the same subject.

Dr. Parkes, in his *Researches into the Pathology and Treatment of the Asiatic or Algide Cholera*, published in 1847, speaks of the collapse of cholera as a "variety of suffocation:" contending with great force, and from a considerable basis of facts, clinical and necroscopical, that the essence of the state of collapse is "a failure more or less complete in the transmission of the blood through the lungs." In order to account for that non-transmission he argues thus: "As the mechanical part of respiration is perfect, and as there is no impairment in the voluntary command of the respiratory muscles, and as the heart evidently beats in many cases till stopped by the want of blood on the left side, and by its accumulation on the right side, we are compelled to look for the cause of such arrest of the circulation in the only remaining element of respiration, namely, in the blood itself." The blood, he infers, is in a changed physical state which renders it more or less unable to pass along the smaller vessels in the system

generally, and in the lungs in particular; and in explanation of this he suggests as not improbable that the "poison" of cholera may effect primary chemical changes in the fibrin of the blood.

Dr. Johnson's theory of collapse, argued by him in various publications from 1854 to the present time, is in its main features an acceptance of the above; but while Dr. Parkes suggests for the assumed primary blood-poison in cholera, that it acts coagulatively or precipitatively on the blood, Dr. Johnson claims for the assumed poison that it has strongly irritant qualities; and while he follows Dr. Parkes in believing that an impeded pulmonary circulation is the central fact in the phenomenology of collapse, he explains the impediment as a spasmodic contraction of the muscular coats of the minute pulmonary arteries due to the irritativeness of his "poison."

The belief that the proximate cause of cholera is a "poison" first acting in the blood is common to Dr. Parkes and Dr. Johnson, as well as to many other writers; and Dr. Johnson builds on that belief his advocacy of a particular principle of treating cholera—the principle, namely, of "assisting nature," by emetics and purgatives, in what he deems to be her "salutary and curative efforts" of vomiting and purging: but Dr. Parkes's doctrine of the state of the circulatory system in collapse, and Dr. Johnson's doctrine of the dependence of that state on spasmodic closure of the minute pulmonary arteries, are doctrines which do not necessarily involve an acceptance of the "eliminative treatment" of cholera, nor pre-suppose any belief that cholera begins as a blood-disease. It is important that the different questions should not be jumbled together as one; particularly important now, because the notion of a primary blood-poison in cholera seems tending more and more to be superseded.

1. First, as regards the state of the circulation in collapse. Personally knowing Dr. Parkes's great accuracy of statement, I attach the utmost importance to the descriptions contained in his work. And their details do certainly in great part justify the generalisation which he makes of them.* But whether the morbid phenomena which he describes are rightly accounted for by the doctrine of arterial obstruction in the lungs (either such as he supposes, or such as Dr. Johnson supposes) is matter of much more doubt: for feebleness of heart-contraction appears to be an invariable fact in choleraic asphyxia; and so far as this affects (or at least predominantly affects) the right side of the heart, so far it tends to produce much such a disturbance of circulation as

* Yet it deserves notice that even among Dr. Parkes's own cases of death in collapse the post-mortem evidence of interrupted pulmonary circulation was not universal; and I may add, though without attaching equal importance to the fact, that a citation of miscellaneous authorities on the state of the heart and lungs in death by collapse (such a citation as was given in 1833 by Prof. Phœbus in chapters 5 and 6 of his classical *Leichenbefund bei der Orientalischen Cholera*) would show still less uniformity of evidence in that respect. Also, in my opinion, the assertion made by Prof. Griesinger (in § 483 of the admirable essay on cholera which forms part of his *Infections-Krankheiten* in the *Handbuch der Pathologie und Therapie*) deserves much weight: viz., "that the distention of the right cavities of the heart appears not to be present during life, as percussion gives (invariably ?) a small area of cardiac dullness." Supposing the general accuracy of Dr. Parkes's descriptions to be conceded, judgment must, I think, be reserved on the meaning of the alleged exceptions. For, whatever question there may be as to the inter-dependence of the symptoms of cholera, it is certain that the disease, in proportion to its flux, tends to reduce more or less rapidly both the volume and the fluency of the blood; and till we know exactly what would be the ultimate anatomical expression of those changed physical states of the blood, taken by themselves, it is impossible to affix a right value to the cases of cholera where post-mortem appearances, or facts observed during life, have not answered to Dr. Parkes's general description of the anatomy of death in collapse.

APPENDIX.

On the Clinical Characters of Cholera, 1866, by Dr. Sutton.

Note by Medical Officer.

would result from the supposed arterial obstruction. Present opinion seems, I think, generally to be that, in the main it is the dynamical affection of the heart (not the supposed obstruction of pulmonary arteries) which gives the true explanation of Dr. Parkes's facts; but this would not of necessity imply, either for the pulmonary or for the aortic circulation, that all the arterial resistences are normal. Whatever ætiological view be taken of the connexion of the symptoms of collapse, it cannot be deemed unlikely that a much diminished volume and impaired fluency of the blood, when they have arisen, should excite certain phenomena of their own in the sphere of arterial contractility, as well as have their own physical consequences, nor again that certain changes of arterial tone should go with certain changes of cardiac action. Be this as it may, some of the phenomena presented in the aortic system in collapse are such as arterial contractility would seem very plausibly to explain. Such are some of the inequalities of temperature and circulation in the diseased body, not only as between internal and external parts, but as between different parts (external or internal) in the aortic circulation. Specially, for instance, I cannot conceive from what other basis to explain the tendency to equalization of temperature between external and internal parts which is apt to show itself in the fatal ending of collapse, and even to continue after death, as though a final relaxation of arterial rigidity permitted the blood at last to find way through its normal channels. And if the cold and cyanosed state of external parts in cholera be not to some extent under control of arterial contractility, I cannot conceive through what mechanism to explain that exceptional state of mammary circulation which permits the continued secretion of milk by nursing women who are in collapse.

2. The belief that a primary "blood-poison" is the proximate cause of cholera, the direct source equally of its intestinal and of its asphyxial manifestations, is, so far as I know, mere hypothesis. It has been much accepted as the only possible explanation of certain supposed, but very questionable, facts in the natural history of the disease; specially in explanation of the supposed fact, that the utmost collapse of cholera may concur with little or no affection of the intestinal canal. It is of supreme pathological importance to be right in the matter of these premisses. Is it, or is not, true that choleraic asphyxia can arise otherwise than in consequence of the bowel-disease? This question has been much perplexed, partly through the vast number of vague assertions which are current on the subject, and partly through an assumption which has often been prematurely, and perhaps wrongly, made, that the significance of the bowel-disease in cholera is to be measured by the quantity of the fluid secretion from the bowel. Properly to discuss the main question, that assumption must be disallowed, and the points be separately considered.

a. That the large, often enormous, fluid discharges which generally characterise cholera represent corresponding de-aquation and de-salination of blood and textures in the patient's body, and that such changes must at least for a time interfere to some considerable extent with all or most of the chemical processes of the body, cannot, I suppose, be disputed. And on the hypothesis that cholera begins in the bowels, it might seem probable that all, or nearly all, the facts of collapse and secondary fever would admit of being referred, directly or indirectly, to that generally enormous flux. Especially it would seem plausible to refer to the altered blood either a power of mechanical obstruction, or a power of provoking resistent muscular constriction, in the vessels through which it has to pass. At present, however, very strong arguments against any such doctrine of collapse are adduced. Some weighty statements on the subject, having in them every appearance of accuracy, are made,

for instance, by Dr. Goldbaum in his recent report (published in Virch. Arch., Feb. 1867) of the experience of the Berlin Cholera Hospital No. III., in the epidemic of 1866; a report which is the more valuable from the fact of the author's having been in part-charge of cholera hospitals in Berlin in the previous epidemics of 1853, 1854, and 1855. Dr. Goldbaum's conclusion, supported by many illustrative cases, is strongly against the doctrine that inspissation of the blood is the cause of the asphyctic state. He (like many previous observers—notably the chief Anglo-Indian authorities, and, in Europe, Magendie, Romberg, Parkes, and others) insists that the relation of flux to asphyxia is rather an inverse than a direct proportion, and that the cases of worst augury are cases which have fallen into collapse after but little or no vomiting and purging. He, moreover, expressly guards against undue importance being attached in such cases to the quantities of fluid (half or two-thirds of a gallon at the utmost) which may be retained within the patient's intestinal canal; pointing out that the contrast is with cases where perhaps as much as seven gallons are discharged by vomiting and purging, and that consequently no allowance made for intestinal contents can affect the truth of his proposition. In this context, too, it seems convenient to refer to the comparison which many experienced observers of both sorts of disease have drawn between the phenomena of cholera-collapse on the one hand, and those of the cold stage of malarious disease on the other. Dr. Goodeve, for instance, in his article on cholera in Reynolds's System of Medicine, arguing that "symptoms similar to collapse may be produced by poisons without any purging," observes that he has "seen people under the influence of malarious poison in Calcutta lie for hours as cold and pulseless, and as embarrassed in the breathing, as in cholera." No doubt both sorts of collapse have very much in common as regards their spheres of manifestation, and much also as regards the phenomena themselves; but of course the likeness between them does not exclude the possibility that they may be induced by very different causes.

b. As regards the other point, materials for judgment are less definite; but certainly, in the present state of information on the subject, the proposition is by no means established that cholera-collapse ever occurs without bowel-disease enough probably to account for it. Abstraction of fluid, I need hardly observe, is not the only way by which abdominal lesions can affect the circulation of the blood. There are channels for nervous, as well as for humoral, sympathy; and the heart's action can be lowered to the utmost (whether with consensual changes of arterial tone, I know not) by abdominal lesions in which little or no fluid is expended. Physiologists will remember those admirable researches of Goltz* and Bernstein†, which elucidate the exact course and mechanism of such sympathies; and every practitioner of medicine or surgery can recal instances where he has seen mortal collapse (substantially, so far as I know, not different from the collapse of cholera) produced by the very onset of traumatic and other abdominal inflammations, sometimes of no great apparent magnitude. In comparison with some of such instances, the least amount of bowel disease which (so far as I know) has ever yet been found in the bodies of persons dead with the cholera-collapse must, I believe, be deemed very considerable. Doubtless there are cases on record where men, stricken with cholera-collapse, are said to have suddenly fallen, even numbers of them together, in the streets or elsewhere in their ordinary pursuits,

* Virch. Arch., vol. xxvi.
† Reichert and Du Bois Reymond's Archiv, 1864.

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"tumbling over each other lifeless," or as if "knocked down dead by lightning," or "as if they had drunk the concentrated poison of the upas tree." It may well be that some of these pictures are unintentionally overdrawn; representing less the real objective occurrences than they represent that utter dismay, that sense of mysterious death too swift for remedy, which severe epidemics of cholera are singularly apt to produce. But, taking them at what they are worth, what reason is there to believe that the sufferers who were so stricken down had not bowel-seizure as the ground of their collapse? No doubt the opinion has been current that cholera, acting in some mysterious way on the total organism, may "kill and leave no sign:" but in proportion as exact morbid anatomy has been cultivated, that opinion has, I think, more and more seemed to rest on a mythical basis; and the doctrine of primary collapse ought at least, without hesitation, to be rejected for cases where post-mortem examination of the bowels has not been made. In illustration of these remarks, I would refer very particularly to the important case given above at page 392 by Dr. Sutton. It was a typical case of *cholera sicca*. It was a case of cholera-death so swift that probably none of the reported "upas poisonings" were swifter. But fortunately the body was anatomised. The whole length of the small intestine was found containing choleraic effusion; and to assume in the face of that fact that the cholera-collapse was primary, would, in the present state of knowledge, be, to say the least of it, a simple *petitio principii*.

In the present state of knowledge, then, I do not find it proven, nor do I see any theoretical convenience in taking for granted, that cholera begins as an active blood-change capable of producing primary collapse. The facts, so far as I know them, can all be reconciled with the belief that cholera begins as bowel-disease, producible by direct contagion without even a passive intervention of the blood, and that all asphyctic phenomena of the disease are supervenient sympathetic phenomena. That, so far as they are facts of cardiac paralysis and arterial contraction, they may be attributed to nervous sympathy between bowels and circulatory system, without reference to the greater or less humoral effect of the coincident flux from the bowels, is at present a tenable view. At the same time I hesitate to accept as proven that cholera-collapse is independent of humoral sympathy. That it may often be apparently so is, no doubt, well shown by the statements I have quoted from Dr. Goldbaum and others. But it must be remembered that in those comparative statements two most important variables are not taken into account. First, there is the varied rapidity of the local morbid process—a very considerable range of difference; and it is imaginable that the power of the intestinal flux to produce collapse may vary with the rapidity, rather than with the mere degree, in which it tends to inspissate the blood. Secondly, there is the varying susceptibility of the individual patient; and that this has range enough to account for very considerable differences of manifestation in the functions concerned in collapse will be evident to anyone who has attentively studied the very kindred subject of febrile rigors. Indeed, the power of both the variables in question may be illustrated from that analogy; for all observers know how essentially the rapidity of the thermal rise is the determining condition for the rigor; and all equally know how one patient suffers rigor to the very verge of death from influences which would not appreciably disturb another one.*

* Doubtless it is in considerations like the above that the meaning is to be sought of an assertion which I find made by Dr. Goldbaum, on the strength of some 300

In questioning the fact of a primary blood-poisoning in cholera, I, of course, do not intend to deny that the blood *during* cholera is poisoned. From our earliest knowledge of the disease it has been on record that, when pregnant women have cholera, the intra-uterine offspring almost invariably dies; and more recently, in proportion as the anatomy of the disease has got to be better studied, cases have accumulated, giving detailed evidence in support of an opinion which had from the first been entertained, that the infant in such cases dies of true choleraic infection. Waving particular reference to earlier cases of this sort (for which see, for instance, Phœbus, 1833, op. cit. § 51 *, and Buhl, 1856, in the famous Bavarian report) I may quote some statements made by Dr. Goldbaum in the report to which I have already referred. In the three last epidemics, he says he has carefully anatomized 22 such infants, and never failed to find appearances which, collectively, he deems characteristic of cholera. "In the stomach and upper part of the small intestines always there was a fluid like rice-water, sometimes a thick mass consisting of exfoliated bowel-epithelium; the heart was always ecchymosed; at the back of the tongue there were swollen papillæ as there are in greater degree in adult cholera-corpses; and in the kidney the yellowish cortex contrasted strongly with the more blood-holding medullary substance." A case of the same sort will be found mentioned below at page 465 of Dr. Thudichum's report; and I think there can be no reasonable doubt as to the meaning of any of these cases. It may, I think, be assumed for certain that the death of the fœtus is death by cholera †, and that the fœtus is infected through its blood. And since its blood is a mere derivative of the mother's blood, the fact seems to be beyond dispute that the mother's blood had cholera-contagium in it. In relation to our main argument, however, the question is virtually unchanged. Is there any reason to suppose that the cholera-contagium in the mother's blood was not a secondary product of disease—was not let into her circulation from the ferment-seething interior of her bowels? In this point of view the case may be usefully illustrated by another, and closely kindred, fact. Dr. Thudichum (*see* below, page 477) has made the important observation, that sometimes in cholera the blood, like the rice-water of the intestinal canal, contains butyric acid. He does not believe that this poisonous product of fermentation is primarily formed in the blood; he believes that it is only to be found there when, after collapse, absorption from the bowels has recommenced, and when evidently the presence of that and other like matters in the blood can be interpreted as a fact of secondary infection from the bowel.—J. S.]

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post-mortem examinations, that the intestinal canal of the dead body does not in different cases show such differences of affection as to explain in any degree the greater or less severity of symptoms during life.

* Among the cases given in Phœbus's work is one where the infant was not actually born dead, but died an hour afterwards with all symptoms of the epidemic disease.

† I have been most anxious, if possible, to bring this assumption to the test of actual proof, by causing infection-experiments to be made with the intestinal contents of such cases; and I have communicated with various persons on the subject. Unfortunately the only fœtus which came within our reach was that referred to in Dr. Thudichum's report. Its intestinal contents were given to Dr. Sanderson for the purpose, and were used by him in the intended manner, but with only a negative result. The time of year had unfortunately been reached when, as he has stated, all infection-experiments failed; and therefore no conclusion whatever can be drawn from this one test of the fœtal rice-water. The general evidence, however, seems fairly conclusive as to their nature.

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On communicability of Cholera by Dr. Sanderson

No. 9.—REPORT by DR. BURDON SANDERSON on the EXPERIMENTAL PROOFS of the COMMUNICABILITY of CHOLERA.

In the beginning of August 1866, I was instructed to make experiments for the purpose of determining whether or not the liquid which transudes through the intestinal mucous membrane in cholera, possesses the property, either in its fresh state or during spontaneous decomposi tion, of communicating a similar disease to animals, and to prepare a report on the subject. The report of Dr. Carl Thiersch, one of the Commissioners appointed by the Bavarian government in 1854, for scientific researches on Asiatic cholera, containing the results of his important infection-experiments on animals, was at the same time placed in my hands, in order that I might, if it should appear expedient, follow out the line of investigation so ably and successfully initiated by him during the epidemic at Munich.

Before proceeding to relate the results of my own experiments during the past autumn, I propose to give a short summary of the results obtained by other observers who, at various periods since the first appearance of cholera in Europe, have endeavoured to gain information as to the mode of its propagation among human beings, by communicating it to the lower animals.

PART I. HISTORY OF PREVIOUS RESEARCHES.

The principal methods by which it has been sought to communicate cholera to the lower animals are the following:—1. By injecting blood of persons affected with cholera into the veins, or by inserting such blood into the subcutaneous cellular tissue; 2. By injecting or inoculating the alvine liquid in the same way; 3. By introducing the alvine liquid into the stomach in considerable quantity; 4. By administering the solid residue obtained by the spontaneous evaporation of the alvine liquid in extremely small doses.

I. *Injection or inoculation of cholera-blood.*—The earliest experiments were made by injection into the veins. In 1831 Magendie injected an ounce of cholera-blood into the veins of a dog without effect, but when eight ounces were employed fatal diarrhœa ensued. After death the venous system was found to be full of black tarry blood, and the condition of the intestines resembled that observed in persons dead in cholera-collapse.*

In 1836, Dr. Giacinto Namias, a well-known physician in Venice, performed a series of experiments which consisted in inserting coagula taken from the hearts of persons who had died of cholera into the subcutaneous cellular tissue of rabbits and closing the wounds by sutures. In these animals death occurred in a few days after the inoculation, and was preceded by slight diarrhœa and other signs of illness. Dr. Namias was led by these observations to believe that he had succeeded in producing real cholera, although the symptoms appeared very ambiguous. During the next two years a number of similar experiments were made by other Italian physicians, particularly by Dr. Semmola. The results were so negative and unsatisfactory as to convince, not only Semmola but Namias himself, that the apparent success of his first inoculations were referable rather to the mode of operating than to the material inserted.†

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* Magendie, Leçons sur le Choléra Morbus, 8vo., Paris, 1837, pp. 126, 127.

† These experiments are recorded by Dr. Jos. Meyer (Virchow, Archiv. f. pathol. Anat. Bd. IV., p. 31), who quotes them from the 77th and 85th volumes of the "Annali Universali di Medicina, compilati da A Omodei."

In 1849, Mr. Marshall, of University College Hospital, made seven experiments with blood taken from the bodies of persons who had died in the collapse stage of cholera. "The blood diluted with about equal "parts of distilled water, so as to permit the fibrine to be removed, "was injected into the external jugular vein of the animals employed, "from which a small quantity of blood was always first allowed to "flow." In the first and second experiment, blood taken 15½ hours after death produced at first exhaustion, subsequently anorexia and slight purging. In the third and fourth the blood was taken 12 hours after death; the results were similar, but in one of the animals the purging was more marked. The fifth and sixth experiments were performed within an hour after the death of the patient. The effects were of the same nature. Mr. Marshall thought that in every instance they might be referred to the "introduction of dead blood charged "with the products of its own decomposition."*

In other experiments blood taken directly from the veins of cholera patients has been employed. Thus Namias injected warm blood from a man in the algide stage of cholera into the veins of a dog, and Calderini repeated the experiment on a couple of rabbits, in each instance without result. Subsequently (in 1849) Dr. Carl Schmidt injected 13 grammes of fresh defibrinated blood of an individual who had been 24 hours ill of cholera into the jugular vein of a cat previously kept 12 hours without food. Even under these favourable circumstances there was no result.† During the next three days there was neither vomiting nor diarrhœa, and the alvine evacuations retained a perfectly natural character. During the same year Mr. Marshall made six experiments, in which blood taken from living patients (all of whom subsequently died), slightly diluted with distilled water and defibrinated, was injected within 20 or 30 minutes after abstraction into the jugular veins of various animals. The quantity injected was from four drachms to six drachms when dogs were employed, or about three drachms for cats and rabbits. In the three observations on dogs the results closely resembled each other. In one there was "prostra- "tion for the rest of the day; bowels slightly relaxed; fæces opaque "white, covered with greenish-yellow mucus; no appetite." Next day these symptoms had entirely disappeared. In the other there was also trifling and transitory alvine disorder, but no other ailment. In the other animals the effects observed were even less marked than in the dogs. In two other dogs somewhat larger quantities of defibrinated blood taken from persons affected with other diseases (pleurisy and injury to the chest) were injected into the veins "without other effects "than those due to the operation."

In 1850 Dr. Jos. Meyer injected two drachms of blood (not defibrinated) taken from the median vein of a patient in collapse, who died 48 hours afterwards, into the jugular vein of a large butcher's dog, which was brought to the bedside for the purpose, the vein having been previously prepared. Not the slightest alteration of the fæces was observed, nor did the animal appear in any way affected by the operation.

II. *Injection or inoculation of the alvine liquid of cholera.*—The only exact experiments of this nature were made by Mr. Marshall at the same time as those already referred to. Pure rice-water liquid,

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* Marshall, "The Communicability of Cholera to Animals," Brit. and For. Med. Chir. Review, vol. xi. p. 398.

† C. Schmidt. Charakteristik der epidemischen Cholera gegenüber verwandten Transudations-anomalien.—Leipzig, 1850, p. 79.

freed from flocculi and other suspended particles by repeated filtration, was injected into the jugular veins of dogs and cats, of which three of the former and one of the latter were employed. All of the dogs were languid and distressed for some hours after the operation, and had slight purging for two days, the fæces being of varied colour, and more or less mixed with slime. The cat was affected in a somewhat similar manner. By the fourth day all had recovered.

III. *Introduction of alvine liquid into the stomach in considerable quantity.*—A good many cases are recorded in which dogs are alleged to have taken cholera by devouring the vomits of their sick masters. One of the most remarkable, and apparently well authenticated, is given by Dr. Meyer, (loc. cit. p. 40,) as follows :—The owner of a large house-dog had suffered from diarrhœa for several days. During the night of the 23rd of August 1850, he was seized with more severe symptoms, and passed numerous coloured liquid stools, portions of which the dog swallowed. He lay under the bed until the death of his master, which occurred 12 hours afterwards, immediately after which (about 10 hours after taking the evacuation) he vomited a pale-coloured liquid, and discharged a yellowish, offensive, and watery dejection. In seven hours he was dead. On the following morning the body was dissected by the well-known Professor Hertwig, of Berlin. Liquid which altogether resembled rice-water, flowed from the mouth, and was contained in large quantity in the alimentary canal. There was venous or capillary injection of the whole external surface of the intestines, the mucous surface being covered with white flaky mucus and reddened throughout. Peyer's patches were reticulated and surrounded by areolæ of injection. The heart and large veins contained dark blood, the condition of which resembled that observed in cholera. The appearances in other organs, which are also given by Dr. Meyer, were not remarkable. Another similar instance is quoted by Mr. Marshall, which is also well authenticated, and many others are referred to by Hering, in the article on "Cholera," in his Veterinary Pathology,* as well as by von Hildenbrandt, in his remarkable observations on the same subject, in the Vienna Medical Yearbook.†

During the epidemic of 1831 various experiments were made in Poland by Dr. Foy, which consisted in the intentional introduction of vomited or dejected liquids into the stomachs of dogs, cats, rabbits, and other animals.‡

In 1849 Mr. Marshall made nine experiments of this nature. In three of these, dogs were employed; in two cats; in the remainder, all of which yielded negative results, a rabbit, two guinea-pigs, and a goat. The two cats recovered. One of them, however, which received four ounces of cholera stool, had purging with creamy discharges. Of the dogs one, to which one ounce of vomited liquid had been given, recovered after slight symptoms ; the others died on the fourth and fifth days. In one of these animals, to which three ounces of rice-water stool had been given, purging came on during the second day, the discharges consisting

* Hering, Specielle Pathologie und Therapie für Thierärzte. Stuttgard, 1858, p. 421.

† Franz, Edl. v. Hildenbrandt. Ueber das gleichzeitige Erkranken der Thiere und Pflanzen zur Zeit herrschender Epidemien, besonders der epidemischen Cholera. Oesterr. Med. Jahrbücher. Bd. XVII., pp. 439, 441, and 606 ; XVIII., pp. 83, 237, 436, 590. Vienna, 1838, 1839. In these papers, the indefatigable author has collected an immense number of instances, observed in all parts of the world, in which domestic animals suffered from diseases resembling cholera during its epidemic prevalence.

‡ Du Choléra Morbus de Pologne. Paris, 1832, p. 32.

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of "black, yellow, and greyish substance mixed." A second dose of similar liquid was given 48 hours after the first, after which the dog had "cream-like" evacuations, "walked unsteadily, crept into a corner and whined." He died during the following night. On dissection the intestines, the mucous surface of which was slightly injected, were found to contain the same creamy substance that had been passed, which "was "neutral or slightly alkaline; diluted with water, it made a smooth "emulsion, like rice-water motions, but without the flocculi. It con"tained epithelium, granular cells (mucous corpuscles), amorphous "matter, and fatty particles, mixed with traces of semidigested starch"cells and muscular fibre."

During the following year another series of experiments of the same kind were made by Dr. Jos. Meyer, who employed dogs exclusively, taking the precaution to keep them under observation for some time previously. All the animals were deprived of food for 12 hours before the liquids were administered to them. Of six experiments one yielded negative results, the quantity given being only two drachms. Of the remaining five, two had purging and other symptoms, but recovered. In the three fatal cases the quantities employed were severally four ounces, one ounce, and three ounces. The liquid was injected in two instances *per os et per anum*, in the other by the mouth only. In one of the animals there was no diarrhœa, and death occurred during the second night; in another diarrhœa came on the same day, and the animal was collapsed and died during the first night. In a third, purging came on during the second afternoon, and death occurred during the following night. The post-mortem appearances were remarkable. In the most marked case they were as follows:—Muscles livid, their vessels containing black blood. The mucous membrane of the stomach was injected, and was smeared with tenacious dirty grey mucus. In the large and the lower part of the small intestine there was black fluid, consisting mostly of altered blood corpuscles, and epithelium. There was punctiform redness of the mucous membrane of the whole of the small intestine, particularly of the duodenum. Peyer's patches were turgid and surrounded by red villi. Mesenteric veins and right side of heart contained black greasy blood. Kidneys congested. In the bladder a small quantity of urine, which coagulated with heat. In each case the liquids employed were evacuated by patients in collapse, all of whom subsequently died.*

During the epidemic of cholera in Edinburgh, in 1853, Dr. Lauder Lindsay, who was then resident physician of the Cholera Hospital in that city, succeeded in producing in dogs a fatal alvine disorder, which resembled cholera, by confining them for a length of time in a small room having a capacity of 1,050 feet, on the floor of which the ejections, dejections, and urine of cholera patients, partly fresh, partly putrid, were strewed, the animals being at the same time fed with the blood, urine, and other fluids and solids obtained from the bodies of persons who had died of cholera. After having been subjected to this treatment for nearly three weeks without marked effect one of the animals was seized with vomiting, purging, and cramps; the animal appeared exhausted, moaned piteously, frothed at the mouth, and a few hours afterwards was found dead. On dissection, "a turbid and opaque fluid of a dirty greenish-yellow colour" was found in the stomach and intestines. The mucous surface of the latter was "copiously lined with viscid mucus," which, "when washed out with water," had precisely the characters of the rice-water stools of cholera. In another dog, which

* Loc. cit., pp. 41–48.

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died in a similar manner, the post-mortem appearances were of the same kind. All the others recovered, although one or two of them exhibited marked disorder.*

IV. *Administration of extremely small quantities of solid residue obtained by evaporation of alvine liquid.*—In all the preceding experiments relating to the effects of cholera evacuations, considerable quantities of the material to be investigated were used. Dr. Lindsay's dogs not only fed on cholera liquids for lengthened periods, but wallowed in cholera filth, and constantly breathed air charged with the volatile products of its decomposition ; and even in the experiments of Dr. Meyer and Mr. Marshall the liquids were measured in ounces more frequently than in drachms. In 1854 it was pointed out by Professor Thiersch, that any inference derived from the effects produced by cholera liquids administered in such large doses would be materially weakened by this very fact, if not entirely vitiated ; for even if it could be shown that cholera can be produced in this way, this would afford no explanation of the mode in which it is conveyed from one human being to another, and consequently no solution of the practical question at issue. This question, he holds, can only be solved by the employment of quantities so small as to be comparable with the quantities in which the cholera poison may be conceived to be introduced into the human body. Dr. Thiersch's experiments were made during the epidemic of cholera at Munich in 1854. His method was as follows :—

Fresh intestinal liquid, either evacuated or removed from the body shortly after death, was placed in a glass and allowed to decompose spontaneously with access of air. If the liquid was left undisturbed, the flocculi suspended in it sank to the bottom, leaving the supernatant liquid somewhat turbid. In each quantity of liquid so kept, a strip of filter-paper was steeped at the end of every day, and then dried in a current of air at the ordinary temperature. In order to determine the quantity of solid matter taken up by each strip of paper it was weighed before immersion in the cholera liquid, and after drying ; the difference indicated the quantity to be determined. By this means the material was obtained in every stage of decomposition and in a form very convenient for administering it in extremely small quantities. The animals selected for experiment were white mice, mainly for the reason that "between the human organs of digestion and those of the mouse there "is no important difference. The intestinal canal resembles that of man "much more closely, for example, than that of the rabbit. Mice thrive "on animal food quite as readily as on vegetable, and the functions of "sanguification and nutrition are carried on much in the same way as in "man. Moreover, mice are very voracious, seldom at rest, and appear "to require a larger quantity of material to warm and nourish them than "larger animals."† According to their habit of nibbling everything that comes in their way, "they did not even refuse the infective paper "which was introduced into their cages along with their food, and was "invariably torn into bits." The mice intended to be employed for experiment were placed in suitable cages, two in each cage. After having been kept at least a week under observation, a square inch of steeped paper was introduced into each cage. Next morning the dose

* Experiments on the Communicability of Cholera to the Lower Animals, by W. Lauder Lindsay, M.D. Edinburgh Medical and Surgical Journal, vol. lxxxi., pp. 275 and 630.

† Haupt-Bericht über die Cholera-Epidemie des Jahres, 1854—Dr. C. Thiersch's Infectionsversuche an Thieren. Munich, 1857, p. 570.

was repeated, and so on for four days, so that each pair of mice received a square of the same paper four times in succession. The following four days were occupied in observing the effects.

The experiments were made in five series. The first and second series were in every respect similar. In each case clear rice-water liquid taken from the small intestine after death was used, and allowed to stand for 18 days, on each of which a paper was steeped and subsequently given as above described to two animals. In the third series the contents of the large intestine were employed. The experiments were continued for 10 days. In the fourth and fifth series the papers were steeped in alvine evacuations of living patients, and were given in one case for nine days, in the other for seven. In all, 55 experiments were made on 110 animals.

Professor Thiersch found that papers prepared during the first few days of spontaneous decomposition produced no effect whatever ; but those which were steeped during a second period, extending in the first series from the 4th to the 10th day, in the second from the 7th to the 15th, in the third from the 5th to the 10th, in the 4th from the 3rd to the 6th, in the fifth from the 3rd to the 5th, yielded distinct results. Such papers were given in all to 56 animals, of which 44 were more or less disordered, and 14 died. On the other hand, papers steeped in liquids still more advanced in decomposition were again found to be inert, for of 34 animals to which papers prepared with these liquids were given, only three were affected, all of which soon recovered.

Of the morbid phenomena observed in the affected animals during life and after death, Professor Thiersch gives the following account :—In all the sick animals the evacuations were more or less deprived of colour, and varied in consistence from semisolid (*kuchenförmig*) to watery. " The constitutional disease manifested itself in diminished activity, " hanging of the ears, and staring of the coat (*struppiges Ansehen*). " As the diarrhœa increased the urine lost its peculiar smell, and ceased " to be discharged. Some of the animals became rigid, and appeared " to be dead." One such animal subsequently recovered. All the animals that died were dissected, with one exception. " On opening " the peritonœal cavity the appearance of the convolutions of the small " intestine recalled those seen in cholera in the stage of asphyxia. The " pink colour of the intestine, the injection of the larger veins, the puffy " distension of the intestinal tube, and the marked rigidity of its wall " were the grounds of resemblance, which became still more striking when " it was found that both the small and large intestines were filled with " watery flaky liquid, alike devoid of smell and colour." No other morbid appearances were observed, excepting that the cells in the cortical substance of the kidneys exhibited changes which Dr. Thiersch regarded as identical with those observed in cholera.

From the preceding facts Dr. Thiersch concludes :—" (1.) That in " spontaneous decomposition of the intestinal liquid in cholera, a sub- " stance is formed in from two to six days which is possessed of specific " activity. (2.) That this substance is not volatile, and has the pro- " perty, when introduced even in the smallest quantity into the ali- " mentary canal of animals, of inducing a disease which agrees with " cholera in the character of the alvine discharges and in the spasmodic " affection of the muscular system. (3.) That when the disease is fatal, " the appearances of the intestinal canal are undistinguishable from " those met with in the bodies of persons dying in the asphyxial stage " of cholera ".*

* Loc. cit., p. 583.

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PART II. THE REPORTER'S EXPERIMENTS.

The following animals were employed in the investigation, viz. :—(1) 26 guinea-pigs, (2) 90 mice, (3) six hedgehogs, (4) four pigeons, (5) five dogs—131 animals in all. In consequence of the peculiar character of the experiments, and the absolute necessity which existed of avoiding even the smallest risk of introducing cholera into localities in which it did not previously exist, very great difficulty was experienced in finding a fit place for conducting the inquiry, and this difficulty was much increased by the unreasonable apprehension which I found to exist in the minds even of well-informed persons, who imagined that the conveying or keeping of a material supposed to be infectious, although in closely corked or stoppered bottles, might give rise to a diffusion of the disease. In consequence of these obstacles I was unable to begin my experiments until the 11th of August.

The *experimental liquids*, whether consisting of alvine discharges, or of the contents of the intestines removed after death, were always treated in the following manner :—

The liquid was placed in a soup-plate, and introduced into a glass chamber communicating with a chimney in the laboratory, by which arrangement the possible diffusion of the poison of cholera in the air was prevented. It was then left to itself, excepting that in case it appeared that the liquid was much diminished by evaporation, distilled water was added so as to restore it to its original volume. In accordance with the method employed by Professor Thiersch paper impregnated with cholera liquid was prepared daily as follows :—A sheet of the best Swedish filter-paper was divided by pencil lines into square inches. Of this paper so divided rectangular pieces were cut, measuring five inches by five inches and a half, so that each contained 25 entire squares, leaving a margin of half an inch along one side. Each piece so prepared was steeped by drawing it through the liquid, and in order to do this conveniently its free margin was seized by a glass clip, having blades five inches wide, similar to that employed by photographers ; and great care was taken that the 25 squares not included in the clip should be evenly and thoroughly steeped. This having been accomplished the superfluous liquid was allowed to drain off and the paper was laid on a frame of glass, by which it was supported horizontally in the interior of a metal box measuring six inches transversely in either direction, open at the bottom and communicating at the top with a flue. In this flue a rapid draught was maintained by a large gas flame kept constantly burning, by which means air was made to pass rapidly over the surface of the paper, while, at the same time, the destruction of all volatile organic exhalations was insured. The time required for the complete desiccation of the paper varied according to the nature of the liquid as well as the state of the atmosphere. Thus it was found that paper steeped in distilled water regained its original weight on a dry day in 40 minutes. Paper steeped in rice-water liquid, obtained from patients in cholera, was usually an hour in drying ; whereas paper prepared with the more tenacious liquid usually met with in the stage of reaction could not be dried in less than three hours. Again, it was found that on damp days the operation lasted three or four times as long as on dry days, and occasionally it happened that the paper could not be dried at all. The weight taken up by each square inch of paper was then determined by the balance. The prepared square which had been weighed in a watch-glass before it was steeped, was again weighed after desiccation in the same manner. The difference of course expressed the weight of solid matter taken up by 25 square inches. On damp days

it is to be assumed that the numerical result given is in excess of the real weight of cholera material contained in the paper. As, however, it was not at the time thought expedient to use any other method of drying, the error could not be avoided.

The following is a descriptive list of the infective liquids employed in the experiments:—

Cholera liquid, No. 1.—Rice water liquid removed by me from the intestines of Martha Brooks, aged 30, who was admitted into the London Hospital on the 10th of August, under the care of Dr. Fraser, having been suddenly seized the same morning with vomiting and purging. She was admitted in collapse, and died the following day without re-action. The lungs were congested and œdematous, and the heart contained fluid blood, both in its right and left ventricles. The intestines were distended to a remarkable degree with rice-water liquid.

Papers steeped in this liquid were prepared daily in the manner above described, from the 11th to the 23rd of August, excepting on the 18th and 19th. The weights of solid matter contained in one square inch of each paper is shown in the following table:—*

Weight of solid cholera-material contained in one square inch of paper, in grains.	Day of preparation.
0·027	August 11
0·056	" 12
0·049	" 13
0·051	" 14
0·081	" 15
0·059	" 16
0·088	" 17
0·131	" 20
0·073	" 21
0·072	" 22
0·070	" 23

Cholera liquid, No. 2.—Intestinal liquid taken after death from the body of Henry Cecil, a middle-aged man, who was admited into the London Hospital on the 6th of August. He died on the 11th in the secondary fever of cholera. After death the following appearances were observed: The lungs, although congested posteriorly, were in general pale, and contained little blood. The whole intestine contained material of gelatinous consistence, which in the duodenum and jejunum was of a greenish-yellow colour, but in the ileum and large intestine of a drab colour. In general, the mucous membrane of the small intestine was pale, but at the lower end of the ileum it was of a deep port wine colour, specked with black. The mucous membrane of the ascending colon was similarly congested, and beset with numerous greyish-red patches of ulceration.

From this liquid paper was prepared in the same manner as before; the weights were as follows:—

* These and the following weighings were performed by my assistant, Dr. Vogt.

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Weight of solid cholera-material contained in one square inch of paper, in grains.	Day of preparation.
0·321	August 11
0·247	„ 12
0·362	„ 13
0·284	„ 14
0·451	„ 15
0·148	„ 16
0·059	„ 17
0·120	„ 20
0·202	„ 21
0·336	„ 22
0·349	„ 23

Cholera liquid, No. 3.—Rice-water liquid taken 12 hours after death from the body of Thomas Hawkins, who died in the London Hospital on the 25th of August in collapse under the care of Dr. Davies. At the autopsy it was noted that both sides of the heart contained liquid blood, and the lungs were soaked and congested, scarcely crepitating posteriorly. The bladder contained about a drachm of milky liquid. The small intestine was distended with rice-water liquid.

The liquid exhibited the usual characters, and was found, on microscopical examination, to contain a great abundance of epithelium. It was kept for eight days, on each of which paper was prepared, as shown below.

Weight of solid cholera-material contained in one square inch of paper, No. 3, in grains.	Day of preparation.
0·066	August 26
0·068	„ 27
0·136	„ 28
0·281	„ 29
0·245	„ 30
0·307	„ 31
0·171	September 1
0·230	„ 2
0·288	„ 3

Cholera liquid, No. 4.—This liquid, which was of a pinkish colour and gruelly consistence, and contained more solid matter than usual, was obtained 22 hours after death from the body of Thomas Donaldson, aged 58, who was admitted into Middlesex Hospital on the 30th of August, in the forenoon, and died at 4 p.m. He had been ill about six hours when admitted, and was already in collapse, having cold extremities, imperceptible radial pulse, vox cholerica, and a temperature of 92°. Both sides of his heart contained dark fluid blood, with loose coagula. The lungs were anæmic. The bladder was contracted, and contained only a drachm or two of liquid-like pus. The mucous membrane of the intestines was of nearly natural appearance. They contained a turbid brownish flocculent liquid, along with viscid mucus. In consequence of its high specific gravity (1,020) and tenacity it was deemed expedient to dilute it with its volume of distilled water. The weights of

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solid matter contained in the paper prepared with the diluted liquid were as under :—

Weight of solid cholera material contained in one square inch of paper, No. 4, in grains.	Day of preparation.
0·052	September 1
0·108	„ 2
0·091	„ 3
0·239	„ 4
0·162	„ 5
0·180	„ 6

Cholera liquid, No. 5.—Rice-water stool of a patient named Stephen Carroll, who was admitted into the London Fever Hospital on the 1st of September in a state of partial collapse, which afterwards became more intense. Diarrhœa had existed for two days. Up to the time at which the liquid used for experiment was obtained, he continued to vomit frequently. His alvine evacuations were watery and colourless, varying in specific gravity from 1,009 to 1,014. Subsequently the vomiting ceased, and the stools became less abundant and more consistent. He died without reaction. After death the intestines were found to be lined with a material of slimy consistence, and yellow colour. The surface was pinkish in the duodenum, where the mucous membrane was swollen and unnaturally firm, dark purple in the ileum. Both ventricles of the heart contained coagulated blood, the left very sparingly. The lungs were dry and bloodless. Papers were prepared with this liquid on the 3rd of September, and on the four following days, as shown below :—

Weight of solid cholera material contained in one square inch of paper, No. 5, in grains.	Day of preparation.
0·148	September 2nd.
0·217	„ 3rd.
0·162	„ 4th.
0·284	„ 5th.
0·379	„ 6th.

Cholera liquid, No. 6.—Intestinal liquid obtained 12 hours after death from the body of Jane Pettit, aged 16, who was taken ill on the 5th of September, and died in Shelton Hospital after 12 hours illness. The small intestine contained a large quantity of colourless liquid,—the specific gravity of which was 1,017—which was used for experiment. Papers were prepared on the 6th, 7th, and 10th of September. That prepared on the 6th contained 0·284 grains of solid matter, that on the 7th contained 0·158 grains, and that on the 10th 0·157 grains in every square inch.

Cholera liquid, No. 7.—Intestinal liquid taken seven hours after death from the body of William Carter, who was admitted into University College Hospital, on the 11th of September, in a state of partial collapse, having suffered from vomiting, diarrhœa, and cramps, since the 8th. He died the following morning without reaction. Both

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sides of the heart contained blood in quantity, and the lungs were soaked with serous fluid. The lower portion of the ileum was of a reddish brown colour externally, its mucous membrane being intensely hyperæmic, especially near the ileo-colic valve. In the larger intestine the mucous membrane could be stripped off very readily, and exhibited several necrosed patches covered with membranous sloughs of a yellow colour and irregular form. The liquid contained in the small intestine, which was used for experiment, was of a brownish colour and ropy consistence, its specific gravity being 1,030. Paper was prepared on the 12th of September, nine hours after the patient's death; it contained no less than 0·474 grains of cholera matter in each square inch. Five days afterwards (September 17th) a second paper was prepared, containing a still greater quantity, viz., 1·53 grains per square inch.

Cholera liquid, No. 8.—Intestinal liquid obtained 22 hours after death from the large and small intestines of ——— Gifford, a labourer, who was admitted into University College Hospital on the 11th of September, having been five hours ill. He died without reaction on the following afternoon. Blood was found in quantity in both ventricles of the heart, while the lungs were pale and free from œdema. The intestinal mucous membrane of the lower end of the ileum was intensely congested, especially around Peyer's patches, and exhibited patches of ecchymosis. The liquid collected resembled gruel, but was speckled with black points. Papers were prepared on the 14th of September, and on the three following days, as shown below.

Weight of cholera-material contained in one square inch of paper, No. 8, in grains.	Day of preparation.
0·207	September 14th.
0·472	„ 15th.
0·566	„ 16th.
0·607	„ 17th.
0·684	„ 18th.

Cholera, liquid No. 9.—Intestinal liquid from the body of Sophia Wood, aged 43, who was admitted into Middlesex Hospital on the 17th of September, and died the same evening. She was admitted in collapse, violent symptoms having existed for 10 hours. Subsequently she rallied slightly, but soon collapse recurred in increased intensity. Under the influence of saline injection into the brachial vein she again improved, but soon after sank. The examination of the body was made 19 hours after death, when it was found that the lungs were soaked with serosanguineous liquid, that the right side of the heart was full of semi-fluid blood, with firm white adherent coagula, the right ventricle being empty. The intestinal mucous surface was quite pale throughout, but exhibited the usual appearance of increased density and opacity. The kidneys were small, the cortex of each being pale, opaque, and remarkably well defined, and the capsule slightly adherent. The bladder was perfectly empty and contracted. The liquid employed had a specific gravity of 1,017. The flaky material, to which it owed its opacity, was found on microscopic examination to consist exclusively of epithelium, on the subsidence of which the supernatant liquid was observed to have a pinkish opalescence. Papers were prepared on the 19th of

September and on the three following days, which contained in each square inch the following weights :—

Weight of cholera material contained in one square inch of paper, No. 9, in grains.	Day of preparation.
0·104	September 19th.
0·098	„ 20th.
0·147	„ 21st.
0·187	„ 22nd.

Cholera liquid, No. 10.—Intestinal liquid obtained 11 hours after death from the ileum of a female child aged 3, who died on the way to University College Hospital after a few hours illness. The material employed was colourless, or slightly tinged with pink, and of gruelly consistence. Its specific gravity was 1,017. Paper was prepared on the 2nd of October, which contained 0·141 grain in each square inch, and again on the 7th, of which the impregnation with cholera matter amounted to 0·319 grain per square inch.

Cholera liquid, No. 11.—Stool of Elizabeth Butterfield, aged 4, passed on the 29th of October about 11 a.m., who was admitted into University College Hospital on the 27th of October, having been seized with vomiting and purging the same morning. When admitted she was already prostrate. The evacuations continued until the 29th, when there was complete collapse, with dilated pupils and suppression of urine. During the day two convulsive paroxysms of a few minutes duration occurred, in which the limbs were rigid and the features distorted. Towards evening reaction set in, and subsequently the child recovered. Paper was prepared on the fifth day after the liquid was collected, but it did not appear necessary to weigh it.

Cholera liquid, No. 12.—Liquid obtained on the 8th of November, immediately after death, by introducing a glass tube into the rectum of Thomas Allen, aged 34, who was admitted into the Shelton Hospital on the same day. He passed rapidly into collapse, and died after 12 hours' illness. This liquid was colourless and semi-transparent. On microscopic examination it was found to contain very little epithelium, the suspended flocculi consisting for the most part of granular matter of variable forms, and protophytes. I observed also crystals of triple phosphate, and remains of food.

Cholera liquid, No. 13.—Rice-water stool of Caroline Hartshorne, aged 36, who was admitted into Middlesex Hospital on the 24th of September, having been attacked 12 hours previously with vomiting and purging. When she was admitted the surface was cold, and the radial pulse imperceptible, but the evacuations had ceased. Subsequently the prostration increased, and the purging returned. The stool employed in the experiments was passed on the day after her admission ; it was of a greyish-white colour, and its specific gravity was 1,010. The patient was dismissed convalescent on the 12th of October.

Cholera liquid, No. 14.—Rice-water stool passed on the 6th of November by Sarah Mockford, aged 40, who was admitted into Shelton Hospital on the 6th of November, and died on the following day. She was in collapse when admitted, having been ill three days previously. No post-mortem examination was permitted

Experiments on Guinea Pigs.

Experiment I., August 11th.—A square inch of the paper prepared on each day of observation from cholera liquid, No. 1 (see Table I.), was given immediately after it had been weighed the second time, to each of two guinea pigs occupying the same cage. For this purpose the square was folded into a pellet, and passed by forceps into the animal's gullet sufficiently far to insure its being involuntarily swallowed. This was continued in the same way during the whole period, with the exception that on the 10th day (August 22) paper of the fourth day* was given to four animals which had already received other prepared paper seven or eight days previously, and this dose was repeated for three out of four successive days. Similarly paper of the fifth day was given for three days in succession to four other animals. During the progress of the experiment no effect was observed, but subsequently, viz., on the 27th and 29th, two died. These had received, on the 12th and 21st respectively, paper of the first and 10th days. During this and the succeeding periods of observation the animals were fed regularly at 9 a.m. on boiled potatoes and bread. Although care was taken to give them amply sufficient, it was found that they had always consumed the whole. The cages were regularly cleaned every morning.

Experiment II., August 11th.—This experiment, in which cholera liquid, No. 2, was employed, was of the same nature, with the exception that paper was given to none of the animals more than once. No signs of infection could be observed during the progress of the experiment, but subsequently one of the animals died (August 28th).

Experiment III., August 27th.—Eighteen guinea pigs were employed in this experiment, which as usual were kept in pairs in separate cages. Nine varieties of infective paper were prepared, as shown on Table III., and two squares of each variety were given to the animals occupying the same cage for four days in succession, each animal receiving one. On the 3rd of September one of the animals to which paper of the fifth day had been given was found dying. It was lying on its side, with its legs retracted. The respiratory movements were violent, the pupils without reaction, and the animal insensible. Ten minutes later the animal expired in convulsion. The appearances observed on examination after death were found, when compared with those met with in the healthy animal, to afford no ground for a conclusion as to the mode of death.

Experiment, No. IV., September 1st.—In this experiment, which was of the same nature as the last, 10 guinea pigs were used. The infective paper was prepared from liquid No. 4. In one of the cages the animals received at first paper of the second day, viz., on the 1st, 2nd, and 3rd of September; and subsequently, after an interval of three days, paper of the seventh day for four days in succession. To the other animals papers of the third, fourth, fifth, and sixth days were given as before, each paper four days in succession. On the 9th no effect had manifested itself, and the animals remained subsequently healthy.

Experiment V., September 4th.—Twelve guinea pigs were the subject of experiment, infective paper No. 5 being employed. Each couple received paper of the same day for four days in succession. No appreciable derangement of health was noted either at the time or subsequently.

Experiment VI., September 7th.—On the 7th 184·6 grains of the liquid No. 6, of the second day, containing 10·4 grains of solid residue,

* The expression "paper of the fourth day" signifies paper prepared three days after the liquid was collected or obtained.

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was made up into 160 pills with bread crumb, each pill containing 0·065 grain of cholera matter. On the 10th 87·5 grains of the same liquid, which had consequently been kept three days longer, was made into 64 pills in the same way, each of which contained 0·056 grain of cholera material. Eight guinea pigs were selected for the experiment, of which four were caused to swallow a pill each, of the second day for four days in succession, while the remainder received in like manner pills of the fifth day. Of the former, one died on the 9th, the other on the 14th, the last day on which the pills were administered being the 10th. Of the latter, one died on the 12th, another on the 17th, the last pill having been given on the 5th. The morbid appearances exhibited by the bodies of these animals were far from characteristic. The mucous membrane of the stomach was slightly injected, probably naturally so. That of the duodenum was of a brighter colour, but the rest of the intestine was pale. The intestinal contents were of the consistence of thin gruel. In the duodenum and in the lower part of the ileum they were colourless, but in the intermediate parts they assumed various shades of reddish-brown or yellow. The liver contained much blood, and the gall bladder was distended with bile of the natural golden yellow colour. The kidneys appeared healthy, and the urinary bladder was distended with urine. Dr. Bristowe, who kindly undertook at my request to examine one of the dead animals, reports to me that he found that the colourless or milky juice which occupied the duodenum and jejunum in such quantities consisted "chiefly of cells partly detached from the "surface of the mucous membrane, partly discharged from the glandular "follicles," and that although in other parts of the intestines these cells were more or less mixed up with remains of food, yet everywhere they were the main constituent of the intestinal contents. Dr. Bristowe further observed that the mucous surface of the duodenum was "con-"gested, especially the villi, the vessels of which under the microscope "were as evident as if they had been injected."

Experiment VII.—As it appeared expedient, considering the results of former observations, to ascertain whether or not more marked effects could be produced by the administration of larger doses, cholera liquid, No. 8, was given on the second day (24 hours after collection) to four guinea pigs. The next and the following day the dose was repeated. During the whole period the liquid was kept in a large stoppered bottle, not more than an eighth full. The experiment yielded no result.

Experiments on Mice.

The experiments on mice were commenced on the 7th of September, when 50 of these animals were placed in 25 cages for the purpose. During the period of observation they were fed on soaked bread, canary seed, and barley. It was obviously impossible, from the size of the animals, to administer the infective paper in the same way as to the guinea pigs; on the other hand, the method employed by Professor Thiersch soon appeared to be disadvantageous, for I found that although some of the animals devoured the paper readily enough, the greater number either rejected it, or, at best, left part of it unconsumed, so that it was very difficult to judge what quantity of cholera matter had been ingested. For this reason the plan was adopted of first steeping the paper squares in bacon fat, to which mice are known to be partial. This expedient was completely successful. The animals, although evidently not hungry, took to the paper with such avidity that it had always disappeared within a few minutes after it was given.

Cholera liquid of the third day. Prepared

Experiment VIII., September 22nd.—Paper prepared from cholera liquid, No. 5, of the third day was given for seven days in succession to

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four mice. The animals were kept under observation until the 4th of October. During the first week transitory horripilation was observed and the fæces were softer than usual, but no other sign of disorder manifested itself.

paper given to four mice. No mortality.

Cholera liquid of the fourth day. Prepared paper given to 10 mice. Mortality 60 per cent.

Experiment IX., September 8th.—Five pairs of mice received for four successive days each a square of paper prepared with cholera liquid, No. 5, of the fourth day. After three doses three of the animals appeared listless and inactive. On the following (fifth) day four died. On the sixth day four others appeared to be ill, of which two died next morning and two recovered.

Cholera liquid of the fifth day. Prepared paper given to 10 mice. Mortality 20 per cent.

Experiment X., September 8th.—The experiment was of the same nature, but the paper was prepared with liquid, No. 5, of the fifth day. After three doses two mice appeared listless, and had horripilation. On the fifth day one of these was again lively, but the other was dead. On the sixth day a third mouse, which had before appeared unaffected, was also dead. The remaining eight mice received on the 13th of September and on three following days paper prepared from liquid, No. 7, in the recent state, without effect.

Infective paper given for 13 days in succession. No effect until the 13th day. Eventual mortality 10 per cent.

Experiment XI., September 8th.—The same experiment; paper prepared with the same liquid of the sixth day being used. On the second day four of the ten mice, and on the third day a similar number, failed to devour the paper. As on the eighth day no effects whatever had manifested themselves, the mice received on that and on the four following days paper prepared with the liquid, No. 6, of the fifth day, and after that for five days more paper, No. 8, of the first day. At the close of this period both of the mice in one of the cages were found to be ill. Of these one died, the other recovered, but the listlessness and horripilation lasted for some days.

Infective paper of the second day, given to 10 mice. Mortality 30 per cent.

Experiment XII., September 7th.—Paper prepared with liquid, No. 6, of the second day, was given for four days to 10 mice. On the fourth day, viz., three days after the first dose, four animals appeared ill. Of these, three eventually died, viz., one on the sixth day, one on the eighth, and the other on the 10th day. The remainder were employed for another experiment on the 14th of September.

Repetition of dose for four days without effect. Appearance of symptoms on resuming, after three days intermission. Mortality 20 per cent.

Experiment XIII., September 10th.—Paper prepared with liquid, No. 5, of the seventh day was given for four successive days, (September 10–13) to ten mice. In one of the cages the first dose was rejected by the animals, with which exception all the paper was swallowed. Until the eighth day the animals appeared altogether unaffected. Paper, No. 8, of the second day was then given for three days in succession. On the ninth day two were observed to be ill, of which one died on the 10th day (September 18th), the other on the 11th (September 19th). The remainder continued well.

Intestines of a diseased mouse given to nine healthy mice. Mortality 55 per cent.

Experiment XIV., September 11th.—For the purpose of ascertaining how far the disease could be communicated from one animal to another, the intestines with their contents of one of the mice which died in Experiment IX. on the day before, was given on the 12th of September, after having been previously incorporated with bacon fat, to nine mice which had not previously received any cholera matter. Of these five died on the second, fourth, sixth, seventh, and ninth days.

Diseased intestine given to seven healthy mice. Mortality 57¦ per cent

Experiment XV., September 14th.—The intestines of two mice which had died on the seventh day in Experiment IX. were prepared with their contents in the same manner as before, and were divided amongst seven mice previously used in Experiment XII. On the two days following the administration of the cholera material, four of the mice were ill, some of them having, in addition to the usual horripilation and loss of activity, blood-coloured liquid evacuations. Next day three were

dead, and the other died two days afterwards, the alvine discharges retaining throughout the same character.

Experiment XVI., September 17th.—The seven mice which had been used in Experiment X., one having been accidentally suffocated in measuring its temperature, were fed on the 17th with the intestinal contents of a mouse which died the previous day in Experiment XII., (10th day) the whole of which was readily swallowed. The feeding was in this case repeated on the two following days. Two mice became ill after the third feeding, both of which died, one on September 22nd, the other on September 26th.

Diseased intestine given daily to seven mice in three doses. Mortality 28 per cent.

Experiment XVII., September 20th.—Four mice were fed with the intestines of an animal which had died the day before, after having been fed with the intestines of a former victim (see Experiment XV.). Two remained exempt; of the other two one had liquid discharges on the sixth day and died the day after. In the fourth similar discharges came on on the 3rd of October (viz., 13 days after the dose), from which it apparently recovered, but was found dead on the 8th.

Secondary infection of four other mice. Mortality 50 per cent.

Experiment XVIII., September 17th.—Paper prepared with liquid, No. 8, of the third day was given for three days to six mice, already used in Experiment I. Twenty-four hours afterwards all exhibited horripilation, and some had blood-coloured discharges. Eventually all recovered.

Third day paper given to six mice. No mortality.

Experiment XIX., September 19th.—Eight mice previously employed in other experiments were fed for four days in succession on paper, No. 8, of the fifth and sixth day. During the first 10 days no symptoms of importance presented themselves, but on the 30th two of the animals had blood-coloured tenacious evacuations, and on the 5th of October both died.

Fifth day paper given for four days to eight mice. Mortality 20 per cent.

Experiment XX., September 21st.—Six mice were fed with material from the small intestine of a patient who had died of cholera, which was sent to me by Mr. Mason, the resident medical officer of Shelton Hospital. It was obtained from the body of a boy aged 14, who died on the fourth day of his illness in (uræmic ?) convulsion. The material was of great tenacity and bright yellow colour, and formed a thick coating, which adhered to the whole internal surface of the portion of intestine sent. On microscopical examination it was found to consist of epithelial elements along with bright yellow granular pigment. Of this stuff 14·8 grains were divided among the six animals, and mixed as usual with bacon fat. Four days afterwards one of the mice had loose blood-coloured evacuations and died on the following day. Of the remainder all had indications of diarrhœa; on the ninth day one of them became worse and died during the night.

Fifteen grains of cholera material divided among six mice. Mortality 33 per cent.

Experiment XXI., September 20th.—Cholera paper No. 9 of the second day was given to four mice for five successive days. No marked symptoms of disorder appeared until the 26th, i.e., two days after the last dose of paper had been given. On that day one of the mice was found ill and died on the day following. One of the others had the usual tenacious blood-coloured evacuations on the 28th, and died on the 30th.

Paper, No. 9 of the second day given to four animals. Mortality 50 per cent.

Experiment XXII., September 22nd.—Paper prepared from the same liquid (No. 9) on the third day was given in the same way to four other animals for six days in succession. During the first week the animals did not seem to be affected, but subsequently they had the usual half-liquid evacuations, horripilation, and listlessness. On the 1st of October two of them were found moribund and were at once for-

Same paper of the third day. Mortality 75 per cent.

warded to Dr. Bristowe for anatomical examination. One of the others lingered till the 7th.

Same paper, fourth day. Mortality 50 per cent.

Experiment XXIII., September 22nd.—Paper prepared from the same liquid kept until the fourth day was also given to four mice on five successive days. Two of them became ill on the 1st of October, and died respectively on the 4th and 8th. The others remained exempt.

Same paper, fifth day. No mortality.

Experiment XXIV., September 23rd.—Paper, No. 9, of the fifth day was given for five successive days to eight mice. On the 26th and 28th some of them exhibited slight indications of alvine disorder, but the animals never lost their liveliness.

Paper, No. 7, given to four animals, of which 75 per cent. died.

Experiment XXV., September 20th.—Paper prepared from liquid, No. 7, of the fifth day was given for four days to four mice. All exhibited symptoms of illness at an early period, and on the third day one was apparently moribund. They afterwards rallied, but on the 1st of October one of them was found dead and another suffering the usual blood-coloured alvine flux. This animal died next day, and soon after another was attacked in a similar manner and died.

Paper prepared from recent cholera stool, given to eight mice. Mortality 25 per cent.

Experiment XXVI., September 25th.—Paper prepared from cholera liquid, No. 13, was given to eight mice for three days in succession. As the liquid contained very little solid matter (the quantity in a square inch of paper being from 0·025 to 0·034) twice as much as usual was given. During the first four days the animals remained well, but on the fifth day two of them showed signs of alvine disorder and died on the day following. In this case the preparation of the paper was commenced one hour after the stool was passed, so that the liquid employed was absolutely fresh.

Recent paper given to 10 mice without result.

Experiment XXVII., October 4th.—Paper prepared 12 hours after death with cholera liquid, No. 10, was given to 10 mice for three days in succession. None of them showed any, excepting the most transitory, signs of illness.

Fifth-day paper of the same kind, given in like manner to the same number of animals. Mortality 30 per cent.

Experiment XXVIII., October 9th.—Paper was prepared with the same liquid five days later; it was given four days in succession (Oct. 10–13) to 10 animals. After the first feeding one of them appeared to be ill, next day it was in the same condition and died the day after. Signs of illness were recorded in three others on the 15th of October, of which two were found dead the following morning. The rest remained well.

Two varieties of paper of the fifth and sixth day respectively, given to 10 mice without result.

Experiment XXIX., November 3rd.—Paper steeped in a rice-water stool (cholera liquid, No. 11), which had been kept for four days, was given to 10 mice on the 3rd of November, and the dose repeated on the 4th, 5th, and 6th. None of the animals were in the slightest degree affected. On the 12th of November they were again fed with paper prepared with another rice-water evacuation (cholera liquid, No. 14), which had been kept five days. The same paper was again given on the three following days. The animals continued perfectly healthy.

Experiment XXX., November 13th.—Paper prepared five days after death with cholera liquid, No. 12, was given to eight mice for four successive days. They remained perfectly well.

Other experiments, also without result.

Experiment XXXI., November 13th.—On the same day paper was prepared with a rice-water evacuation of the same patient, from whose intestines the liquid, No. 12, was obtained. It was given to 10 mice for four days in succession without the slightest result. Another quantity was dialysed through parchment paper, and paper steeped in the usual manner in the diffusate. This was given in the same way to six other mice. No result.

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The results of the preceding experiments may be tabulated as follows :—

NUMBER of MICE employed in EXPERIMENTS on CHOLERA LIQUIDS from September 7th to October 15th, the Number of Doses of Cholera Paper given, the Number of Animals apparently ill in consequence, and the Number and Per-centage of Deaths.

Nature of Liquid.	Number of Animals employed in Experiments.		Number of Doses given to each couple of Mice.		Number of Animals affected.		Number of Deaths.	
	Alvine Evacuations.	Intestinal Contents.	Alvine Evacuations.	Intestinal Contents.	Alvine Evacuations.	Intestinal Contents.	Alvine Evacuations.	Intestinal Contents.
Liquid kept								
Less than 24 hours (first day) -	10	26	27	41	2	2	2	1
" 48 hours (second day)	–	22	–	42	–	8	–	7
" 72 hours (third day) -	4	10	14	21	4	10	0	3
" 96 hours (fourth day) -	10	4	20	10	8	2	6	2
" 120 hours (fifth day) -	20	22	40	44	7	10	5	5
" 144 hours (sixth day) -	10	–	20	–	0	–	0	–
" 168 hours (seventh day)	10	–	20	–	0	–	0	–
	64	84	141	158	21	32	13	18

The numbers given in the above table do not at first sight suggest any very obvious relation between the *stage* of spontaneous decomposition represented by the paper employed, and the results of the experiments. If, however, as in the following table, we substitute the *relative* numbers for the absolute ones, the significance of the facts becomes much more apparent.

PERCENTAGE of *Attacks* and *Deaths* relating to each Day of spontaneous Decomposition.

Period of Decomposition.	Per hundred Animals employed in Experiments.	
	Number affected.	Number that died.
First day - - -	11	8
Second day - - -	36	32
Third day - - -	100	21
Fourth day - - -	71	57
Fifth day - - -	40	24
Sixth day - - -	0	0

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As regards the mortality, the numbers do not seem to be comformable to any law. They merely show that the relative number of deaths was greatest among animals to which paper of the fourth day had been given. But the criterion of the efficiency of any assumed cause of disease is evidently to be sought for not in the *mortality* of the persons or animals subjected to its influence, but in their *liability* to attack. According to this acknowledged principle in etiology, we have to look for indications of the comparative infectiveness of the liquid at different periods, not in the number of deaths, but in the numbers affected. The significance of the latter, as given in the second column of the table, scarcely needs to be pointed out. They clearly show that the liability to attack was greatest as regards the third and fourth days, much less and nearly equal as regards the second and fifth days, and least as regards the first day. In some instances, however, the intestinal liquid appeared to have attained its full virulence, even as early as the second day, as may be inferred, not only from the large proportion of deaths among animals to which second-day paper was given, but still more strikingly from the high mortality (48 per cent.) observed in Experiments XIV. to XVII., in all of which the material used was given less than 48 hours after the death of the animal from which it was taken.

Liability to attack greatest on the third and fourth days.

The same experiments afford evidence that the disease produced in mice by the administration of cholera material in small doses, can be readily communicated from the affected animals to others of the same species, and that when so communicated it is quite as fatal as when received primarily. Thus, of 27 animals which were the subjects of these experiments, 14 became ill, and 13 died.

Disease readily communicated from affected animals to others of the same species.

There appears to be no difference as regards infectiveness between the alvine evacuations and the liquid removed from the intestines after death. The two kinds of liquid appear to differ only as to the quantity of epithelial cells contained in them, which, although they are so abundant in the latter, are often scarcely to be detected in the former.

Alvine discharges and intestinal contents equally infective.

The negative results obtained in the experiments made during the month of November can scarcely be attributed to any other circumstance than the comparatively low temperature which then prevailed, for in every other respect the conditions of experiment were identical. It is specially worthy of note that not only none of the animals died, but that none of them showed the slightest signs of indisposition.*

Negative results of experiments performed during November.

Since the above was written Dr. Thudichum has been good enough to place in my hands the results of important experiments as to the communicability of cholera to mice made by him (in connexion with his chemical inquiry concerning cholera) at an earlier date than those recorded in the preceding pages. These experiments, in which 51 mice were employed, were of the following nature :—

Important additional experiments of Dr. Thudichum.

First Series.—Intestinal liquids, collected respectively from the jejunum, ileum, and colon of a patient who had died of cholera on the 10th of August, were allowed to stand for 14 days (August 10th–24th). On the day of collection, and on the seven following days' paper was steeped in each liquid according to the plan adopted by Prof. Thiersch. Of the 24 varieties of paper so prepared, each was given on the day of preparation to two mice occupying the same cage, the dose being repeated on three other days, within a fortnight of the commencement of the ex-

* The first series of experiments on mice were made between the 9th of September and the 10th of October, when the mean daily temperature was 55·9°; the second series between the 3rd and the 13th of November, when the mean daily temperature was 49·0°.

periment. Thus each pair of mice received four successive doses of paper steeped in liquid at the same stage of spontaneous decomposition.

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Of these 48 animals seven were affected, and of these five died. Of the deaths, two occurred in the same cage in animals to which paper steeped in liquid of the second day (from the ileum) had been given, one of the fourth day (jejunum), and two also in the same cage of the seventh day (ileum). Of the two animals that recovered, one had received paper of the fourth day (colon), the other of the eighth day (jejunum.) On the 10th, 12th, 13th, and 14th days, six drops of the liquid was given in each instance to two mice without effect.

Second Series.—Ten mice were fed for three consecutive days, viz. on the third, fourth, and fifth after collection, with liquid obtained on the 25th of August from the small intestine of Thomas Hawkins (*supra*, chol. liquid, No. 3) the dose given each day to each animal being six drops. None of them showed any sign of disorder. Ten other mice were subsequently fed with liquid from the colon of the same patient on the third and fourth days after collection. Of these, two (occupying the same cage) died six days after the second dose. They had received liquid from the colon in one of the previous experiments 10 days before. Ten other mice received in the same way, on the second and third days after collection, liquid from the small intestine of another patient. Of these two, occupying the same cage, died five days after receiving the second dose. Ten days before, paper of the second day had been given to them in one of the experiments of the first series. Finally, 10 mice received similar doses of rice-water stool of the third day without effect.

Phenomena of Cholera Infection in Mice during Life.

Difficulties of observation.

From the circumstance that the animals were kept in a cellar to which there was access only during certain hours of the day, it was not possible to observe them so constantly as was desirable. Moreover it is extremely difficult to appreciate the phenomena of disease in so small an animal as a mouse. The disease produced by the administration of cholera liquids to mice declares itself, like other febrile affections of the lower animals, by staring of the coat or horripilation, a phenomenon strictly analogous to shivering. Whether this is accompanied or succeeded by an increase of temperature, or any other symptom of pyrexia, I have not been able to ascertain.

Loss of activity.

The most constant indication that the animal was under the influence of the poison was the loss of motility and excitability.* At first the animal remains quiet, as if listless or drowsy, but can be easily roused into activity; subsequently all reaction ceases. Whenever this condition of collapse exists in a well-marked degree, it is found that the temperature of the body is correspondingly diminished. Thus, in animals so affected, readings of the thermometer were obtained as much as 20° below the natural standard.† So extraordinary a loss of temperature seemed at first so incredible that I was inclined to believe that some error of observation had been committed, but repeated measurements confirmed the accuracy of the results. In general a very low tempera-

Diminution of temperature.

* In one of the animals observed by Dr. Thudichum the hind legs appeared to be paralysed. This was succeeded shortly before death by stiffness and arching of the back.

† In order to measure the temperature of a mouse the best way is to place the animal in a cylindrical test glass of such size that it has just room to coil up its body in the bottom. Under such circumstances the animal usually places itself with its back against the sides of the glass and its belly towards the centre. If then a very sensitive thermometer, having a slender cylindrical bulb is selected, and its bulb is introduced into the centre of the glass, it can be kept in contact on all sides with the animal's body. By this method I found that in measuring the temperature of healthy animals, readings were obtained which varied from 98° to 100°.

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ture was a certain precursor of death, but in two remarkable instances recovery took place after the animals had remained motionless and apparently lifeless, with a temperature below 80°, for more than a day.

Characters of alvine discharges.

The most important characteristic of the affection is to be found in the alterations of the alvine discharges. In the natural state the fæces of the mouse consist, as is well known, of olive-brown dry fusiform masses, usually connected together at their apices by a filament of ropy mucus, so as to form a necklace. But in diseased animals these characters are entirely lost; the evacuations are always softened, but vary in consistence from that of the excrement of the ox to complete fluidity, and in colour from olive-brown to intense dull red—a fact which probably led Professor Thiersch to believe that they were stained with blood. Those which are most fluid are remarkably slimy and tenacious, so much so that it constantly happened that the tails and other neighbouring parts which were smeared with the alvine discharges adhered firmly to the floor of the cage. Of course this could not have happened unless the animal had remained motionless for many hours.

Post-mortem Appearances of the Mice.

During the month of September I dissected about 20 mice affected with cholera, more or less completely. During the progress of the inquiry a certain number were forwarded to Dr. Bristowe, who had kindly consented to examine them, and has since furnished me with notes of his observations.

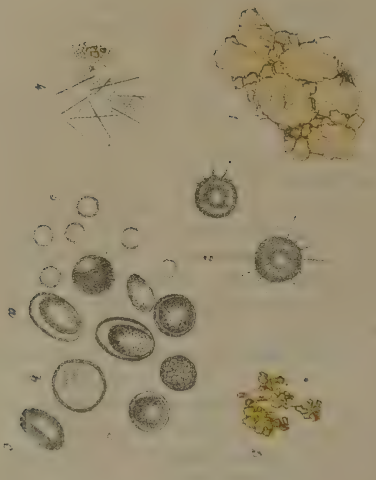
My attention was for the most part confined to the alterations of the abdominal organs, and particularly to those of the intestinal canal. I repeatedly examined the liver and kidneys, but was unable to detect anything abnormal. The urinary bladder was usually empty, but sometimes contained a small quantity of turbid liquid. The stomach was sometimes empty, sometimes contained remains of food.

Tendency to decomposition.

Both in the large and small intestines the tendency to decomposition was so marked, that unless the animal was dissected immediately after death the parts assumed a dark leaden colour, and became so soft and pulpy that they could not be manipulated. The contents of the small intestine were sometimes liquid, but more commonly of gruelly consistence. In the upper part, particularly in the duodenum, the material was usually either colourless or greyish white, but sometimes gamboge yellow. In the ileum it was always more or less stained, the colour varying from Indian red, through orange to gamboge. In the large intestine the liquid was of a similar consistence, but much more tenacious, and of a deeper and more decided blood colour. Fæcal masses could not be distinguished, but in several instances collections of paper fibre were found. With the exception that colouring matter is more abundant in the cæcum and colon than in the ileum, I am not able to point out any difference between the contents of the two cavities.

Epithelium.

In some cases the liquid contained in the duodenum was found to consist principally of débris of food, but in general it was mixed in excess with epithelial elements. The epithelium was usually in clumps, and often exhibited the arrangement which characterises that which covers the intestinal villi. Along with these were to be observed cylindrical masses of cells containing fine granules, which appeared without doubt to have been discharged from the mucous follicles of the stomach and intestine. Towards the lower end of the ileum the same appearances presented themselves so far as relates to the epithelium, the principal peculiarities consisting in the addition of a variable proportion of colouring matter and in the presence of certain products of decomposition. The colouring matter exhibited a pretty uniform



character. It occurred in semi-transparent masses which by transmitted light were of a gamboge or canary-yellow colour, whereas the hue they communicated to the liquid was dull red. These masses were sometimes botryoidal, as if composed by the fusion together of numerous smaller masses, sometimes separate and granular. The appearances referred to above, as resulting from decomposition, were observed in every animal dissected without exception, even though the dissection was performed immediately after death.* Rod-like bodies, resembling in form and structure the fronds of Oscillatoria, but devoid of colour, covered the field of the microscope. Along with these organisms, which possessed an active molecular motion, were occasionally found filaments and sporules of fungi.

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Explanation of the accompanying Plate.

Unusual appearances observed under the microscope in the intestinal contents and alvine discharges of mice affected with cholera. 1. Colouring matter in semi-transparent masses ; 3. The same in granules ; 2. Protozoa, resembling actinophrys ; 4. Rod-like bodies ; 5 and 6. Structures of uncertain character, viz., 5, hyaline bodies which occurred in immense numbers in the contents of the large intestines (*possibly* stromata of blood corpuscles) ; 6, cell-like bodies, some oval (*a*), some spheroidal (*b*), occasionally, as in (*c*), exhibiting partial inversion of their walls.

In addition to these elements, cell-like structures of oval or spherical form presented themselves in all the animals, having the following character. Under the microscope the cell wall is seen as a strongly defined dark line of appreciable thickness. It encloses a central mass of hyaline stroma, in which highly refractive granules and fine non-refractive molecules are embedded. This mass appears to lie free in the cell cavity, has a well-defined pale margin, and possesses a greenish hue, by contrast with which the transparent space between it and the cell wall looks reddish. These bodies vary in diameter from $\frac{1}{1000}$ to $\frac{1}{1400}$ of an inch. They are met with in great abundance in the lower part of the ileum, but more especially in the cæcum and large intestine. They are also found in immense numbers in the fæces of diseased animals.

Other organic forms.

I append here, by Dr. Bristowe's permission, the notes which have been forwarded to me by him, only observing that the above description was written before I had read them, and that our dissections were made independently.

Dr. Bristowe's pathological notes and observations.

"There was in every case a remarkable tendency to decomposition " of the bowels. The small intestines generally contained a largish " quantity of pale yellowish fluid, mixed with bubbles of gas. The " cæcum was more or less distended with fluid of a dusky reddish hue, " and similar fluid was also found in greater or less quantity in the " colon and rectum. From the anal orifice sometimes mucus, some- " times a little solid lump of fæces was extruded.

"The fluid in the intestines always contained detached intestinal " epithelium, and sometimes an immense quantity of it. The cells " were mostly separated from one another, but were sometimes in " groups as if they had come off in flakes either from the surface of " the mucous membrane or from the interior of follicles. Such cells " were met with even in the mucus exuding from the anus. There " were also throughout the whole of the intestinal tract vast numbers " of low vegetable organisms, some consisting of two joints and under- " going constant movement, others of several successive joints and " either moving or stationary (*Bacteria*, &c.)."

* In several instances moribund animals were killed in order to observe the condition of the intestines unaltered by putrefaction.

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Dr. Bristowe further refers to "round or oval well-defined thick-"walled cells, apparently parasitic," which, he says, existed "in greater "or less number in the small intestine, but were always most numerous "in the cæcum and large intestine." He also observed "numerous "oval, slightly curved cells with a single nucleus," of the nature of which he is unable to form a decisive opinion. He adds, "In the notes "I have preserved of microscopic examinations I find no evidence that "the reddish or brownish colour of the fluid in the cæcum and colon "was due to blood. I have an impression, however, that in one case "at least, blood corpuscles were present." In some instances the mucous membrane of the bowels appeared to Dr. Bristowe to be distinctly injected.*

Experiments on Hedgehogs, Pigeons, and Dogs.

Experiment XXXII., September 7th.—Six hedgehogs were placed, on the 7th of September in three cages. On the following day 108·2 grains of cholera liquid, No. 6, of the third day, was divided amongst them, so that each received 18 grains. The liquid was mixed with a small quantity of milk, and was entirely consumed. On the day after, 150·2 grains was mixed with milk, and divided among the six animals in the same way. On the 10th 141·7 grains, and on the 11th 138·2 grains, were given in like manner. During the period they were fed with a sufficiency of cat's meat, and appeared well. On the afternoon of the 12th one of them died, having been alive and tolerably well in the morning. On dissection, the appearances of the intestines and their contents were found to be in accordance with those observed in the mice that died under the influence of cholera infection; but unfortunately the examination could not be made until 50 hours after death. As no further effects presented themselves, one drachm of liquid, No. 8, of the second day was on the 14th of September given to each couple of hedgehogs, that is, placed in each cage, and entirely consumed. Similar doses were given on the 15th, 16th, and 17th. The hedgehog which occupied the cage in which one had died had of course a double dose. Neither during the period of observation nor subsequently, did any of these animals appear to suffer from alvine disorder.

Experiment XXXIII., September 24th.—On the 22nd of September four pigeons were fed with twenty-four peas which had been previously steeped in cholera liquid, No. 9, of the fifth day. On the day following 40 similar peas of the sixth day were given, and on the 24th 40 more of the seventh day. No effect followed from this experiment. Subsequently the pigeons were freely fed on peas steeped in various cholera liquids without the slightest result.

Experiment XXXIV., August 12th.—Four dogs were fed with various quantities, not exceeding one ounce at a time, of cholera liquids. Two dogs unfortunately escaped before the effects could be observed; the two others were subjected to the same treatment repeatedly without the slightest result.

Note by Medical Officer.

[In supplement to Dr. Sanderson's report, I have two observations to make.

First, Dr. Goldbaum, in his report on the Berlin Cholera Hospital, No. III., published in Virchow's Archiv, vol. 38, describes certain experiments performed by him, in imitation of Thiersch, on dogs and rabbits, and, as these experiments gave only negative results, concludes

* Since the above was written Dr. Thudichum has furnished me with notes of his dissections of seven mice under his observation, in which the appearances were of the same nature as those described.

" that neither fresh nor decomposing cholera-evacuations are competent to produce choleraic phenomena in the lower animals." Also, in No. 44 of the Berlin *Centralblatt für die medicin. Wissenschaften*, a like conclusion is suggested by Drs. Guttmann and Baginsky, on the strength of subcutaneous rice-water injections which they had practised on three rabbits and a dog. And in No. 54 of the *Centralblatt* Dr. Stockvis draws the same conclusion from a total of 43 experiments performed by him in various ways on rabbits, dogs, pigeons, frogs, and [query, how many?] mice. But wholly as regards the first two of these contradictions, and in great part as regards the third, it will be evident that the conclusion drawn is far too large for the premisses. Dr. Sanderson's experiments on dogs also gave no result; but the impotence of the agent as against one sort of animal is no disproof of its virulence against other sorts. The positive results of Thiersch's original experiments on mice, and of the experiments here reported of Drs. Sanderson and Thudichum, would retain their full value in regard of the animals experimented on even if all other animals should prove insusceptible of the influence; and that value, in explanation of the facts of human infection, is, in my opinion, conclusive. It is true that on some mice Dr. Stockvis experimented without result: apparently not on many, for he refers to the animals as unsuited for the purpose, and even intimates that they might have been left out of his account: but then it must be remembered that even the affirmative experimenters with mice did not always get positive results. I may add that Messrs. Legros and Goujon (in Robin's *Journal de l'Anat. et de la Physiol.*, 1866) quote negative results from experiments of theirs, which purported to follow Thiersch " avec une minutieuse exactitude," but which, as having been performed on rats, hardly fulfilled that description of them; for Thiersch even attaches some importance to the fact that his mice were white mice.*

Secondly (and this is of important bearing on alleged discrepancies of experimental evidence) some very interesting questions arise as to the uniformity, or absence of uniformity, of infectant power in the choleraic contagium under varying conditions of *time* and *place*. As Prof. v. Pettenkofer has admirably argued, and as I briefly showed in my last year's report, the unquestionable fact of the contagiousness of cholera has to be reconciled with two very important qualifications: first, that the disease, notwithstanding all its contagiousness, apparently does not, except in parts of Asia, admit of being naturalized and made habitual among populations, in the style of our ordinary current contagia; next, that, even when cholera is most epidemic in a country, there are spots where its contagium may again and again be introduced, yet again and again without result; and that while in some such spots this kind of immunity has shown itself not uniformly, but only in particular epidemics and in connexion with peculiarities of season, in other spots, and apparently from fixed conditions of soil, the immunity against the pestilence has seemed absolute. These qualifications are of incalculable importance to every truth-seeking student of cholera, and involve, of course, the hidden springs of those " caprices," which the laity deems so mysterious and inexplicable, in the localisations and periodicities of the disease. Why, for instance, was it (see p. 322) that, in our East London epidemic, the Limehouse establishment for pauper children, standing in the midst of a gravel district, but on its own little island of brick-earth, escaped quite unharmed by the pestilence? And why was it that in Dr. Sanderson's series of experiments (see p. 452) abundant positive results were obtained in September and October, but exclusively negative results in November? The time has not yet come for me to venture

* See a recent paper by him, in vindication of his former experiments, Zeitschr. für Biologie, 1867, p. 138.

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to argue the whole story of those qualifications; but provisionally I must repeat my deep sense of the value of Prof. v. Pettenkofer's researches, adverted to in my last report, both as contributing new knowledge, and as suggesting right directions for inquiry. It appears certain that henceforth no local health-officer will be properly up to the standard of his scientific duties, unless he thoroughly knows the distribution and stratification of soils in the district for which he acts, nor unless he also maintains such systematic and exact observation of the height of wells as will enable him always to speak with precision as to the movements of water-level in the soil: for it seems established that these are two great governing influences in relation to the spread of disease.—J.S.]

No. 10. *On Cholera chemically investigated by Dr. Thudichum.*

No. 10.—REPORT by J. L. W. THUDICHUM, M.D., on CHOLERA CHEMICALLY INVESTIGATED.

A. Introductory general Account of Proceedings.
B. Post-mortem Examinations, anatomical and chemical, of Persons dead of Cholera.
- (*a*) Preliminary remarks.
- (*b*) Abstracts of cases.
- (*c*) Summary of observations concerning formation and excretion of urea.
- (*d*) Special account of chemical examination of the bile from the foregoing cases.
- (*e*) Summary of observations concerning the liver and bile.
- (*f*) Observations concerning the state of the blood.
- (*g*) Observations concerning the state of the epithelia.
- (*h*) Observations concerning the Parenchyma of Organs.

C. Chemical Examination of intestinal Contents and rice-water Evacuations.
D. Short Account of the general features of Urine of Cholera-reaction, with special Supplement on choleraic Urocyaninogen.
- § Choleraic Urocyaninogen.

E. Clinical Observations bearing upon the laws of Temperature in Cholera.
- (*a*) Abstracts (alphabetically arranged) of cases upon which observations of Temperature were made.
- (*b*) Summary of results of clinical observations bearing upon the laws of Temperature.
- (*c*) 40 tables, alphabetically arranged.

A. INTRODUCTORY GENERAL ACCOUNT OF PROCEEDINGS.

The objects of these researches, as proposed to me on August 7th, 1866, by the Medical Officer of the Privy Council, were as follows: "By "investigation of choleraic discharges, and of the diseased body "after death, and by such auxiliary observations of the sick as may "be needful, to ascertain *what successive chemical changes are under-"gone by the body in the progress of cholera, and what relation "subsists between those changes and the symptoms presented by the "patient during life.*"

Immediately on being commissioned as above I put myself in communication with several of the medical officers of the London Hospital, and was fortunate enough to obtain the courteous permission of Dr. Andrew Clark to institute observations upon the patients under his care. I also had valuable opportunities afforded to me by Mr. H. G. Sutton, M.B., and Dr. Hughlings Jackson, for examining parts of bodies in the dead-house, and facilities which enabled me to continue their scrutiny at the Pathological Laboratory, St. Thomas's Hospital.

As the epidemic had passed its acme and was showing signs of abatement, I endeavoured to collect observations with all possible despatch. I therefore engaged several qualified assistants to make observations under my directions.

I next made it my special duty to observe a great number of patients in various stages of cholera, and to compare the clinical phenomena shown by victims of this epidemic with the experience which I had gained in three former epidemics and with the most important literary records, in order to be able to attach the chemical researches in my programme as closely as possible to distinct pathological phenomena.

Concurrently and in conjunction with the foregoing I instituted a special series of observations of the systemic temperature of cholera patients as exhibited in the axilla, with a view of measuring thereby the amount of chemical change in relation to time. Those observations were carried on upon 39 cases, representing many varieties and stages of cholera, excepting, however, the first stage, in which no case came under observation. In most instances from four to six observations in 24 hours were taken upon each case, and recorded, together with the synchronous number of pulsations and respirations, on forms of tables specially printed for the occasion. Three assistants relieved each other for observation during the six four-hour periods of each day, while many patients had to be observed. The results of these observations I have perspicuously represented on 39 tables, arranged according to the alphabetical succession of the patients names, and submitted in Section E. *c*.

Short abstracts of the clinical histories of the cases upon which the foregoing observations were made, were collated, partly directly from the examination of the patients, partly from the clinical records of the hospital. Many of these abstracts, which are valuable mainly as guides to the tables, have been supplied with a short commentary on prominent features of the course of the variations of temperature (T), pulse (P), and respiration (R), of the cases to which they belong. These short clinical histories are alphabetically arranged in Section E. *b*.

By means of the arrangements made as above for the auxiliary observations of the sick I was enabled to ensure and control the collection by the nurses of a number of specimens of specific choleraic discharges. Amongst these were a number of rice-water evacuations. I was much surprised to find the quantity of fluid obtainable from any one case on the whole very moderate, varying from about one ounce as the minimum to nine ounces as the maximum. Although about 40 specimens were secured, the total amount was insufficient for the performance of the entire series of chemical analyses contemplated, and had to be supplemented by the much more copious rice-water contents of the intestines of persons who had died in the early stages of collapse. This unexpected scarcity may be explained by the fact that most persons were brought to the hospital in a state bordering upon or being actual collapse, when little or no fluid capable of transudation remained in their bodies. The accounts which had been given by nurses of the copiousness of the discharges had been either a mistaken conclusion from their frequency, or an exaggeration altogether. The chemical experiments instituted with rice-water are related in Section C.

A number of specimens of rice-water were used for ascertaining the point of actual or greatest infectiousness, by means of experiments upon animals; but as it was ascertained that their results would not be sufficiently rapid to yield conclusions available for the chemical inquiry, the experiments were suspended, and the animals handed over to Dr. Sanderson, with an account of the experiments already performed.

In the course of the auxiliary clinical observations a number of specimens of first, or at least, early urine from the stage of reaction were collected. As the practice of the hospital made it impossible to arrange the collections with reference to physiological time, and as I was in no case

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certain of having obtained the entire quantity voided, and as many specimens had stood for some time before I obtained them, they were used for microscopic and qualitative chemical testing only. Using the partially decomposed specimens for particular inquiries only of which they admitted, I employed most of the really valuable material upon the research on the nature of a blue substance obtainable from cholera urine, to which I have given the name of "Choleraic urocyanine," and of a red substance occurring in the same secretion, to which I have given the name of "Choleraic urorubine." A short summary of the observations on the specimens of early urine of reaction is contained in Section D, to which is subjoined my account of the investigation of choleraic urocyanine.

I was also in a position to witness, or myself to ascertain, most of the general and some of the microscopic appearances of the bodies or parts of bodies after death in upwards of 30 cases, and make special records concerning about 20 of them. The materials thus obtained made it possible to subject to chemical analysis upwards of 113 separate specimens, amongst them 66 entire organs; 5 specimens of muscular tissue, each upwards of a pound in weight; 15 quantities of blood, each being the whole that could be obtained from the heart and great vessels by careful manipulation; the rest being contents of gall-bladders (19), cerebrospinal fluids, urine, and rice-water contents of intestines removed from the respective cavities during the post-mortem examinations. The description of the post-mortem examinations, and of the chemical investigations of organs and fluids, are given in Section B.

The experience which has been gained by this inquiry is invaluable. Not only have the researches on other pathological subjects carried on simultaneously with the research on cholera profited incidentally by it, and *vice versâ*, but the entire method of putting general questions on pathological chemistry has been for the first time severely tested, and as far as the opportunities and materials reached successfully handled.

B.—Post-mortem Examinations, anatomical and chemical, of Persons dead of Cholera.

(*a*.) *Preliminary Remarks.*

(*a*) *Preliminary remarks* concerning the arrangement of this chapter.

The following post-mortem examinations of persons dead of cholera, although made with due attention to the exigencies of the pathology of that disease, were more particularly intended to furnish the materials for the chemical inquiries concerning the formation and excretion of urea and biliary acid; for as these substances are the main products of the principal chemolytical processes of the economy, it was to be supposed that their bearing, that is, presence or absence, scarcity or accumulation, in the cholera-body, might furnish some insight into parts or stages of the cholera process, and assist in the interpretation of clinical phenomena ascertained by the methods of physical diagnosis. These anticipations have to some extent been realized. The observations concerning the formation and excretion of urea will be found to lead to the same conclusion as the clinical observation of temperature, namely, that there is in the essential stages of the cholera process a great diminution of the oxydation of albuminous substances, in consequence of which temperature and vital power or irritability fall to a point approaching extinction, or to extinction itself. The observations concerning the formation of bile lead to a similar conclusion, but this has not necessarily the same direct importance as that concerning the formation of urea; and considering how little defined are the views of physiologists on the nature and uses of bile and of the hepatic function,

would perhaps not be admitted by all pathologists with the same readiness as the conclusions derived from the bearing of urea. Attention was paid to the state and distribution of the blood, but no complete analyses were even attempted, as the methods hitherto proposed lack the conditions of successful application in an inquiry of this kind, namely, precision and readiness. The condition of the epithelia of the most important organs invited some special observations, which were accordingly made, and brought in connexion with the general idea of the choleraic process, which seems best to unite the facts hitherto accumulated in science. The arrangement which it has been thought most desirable to adopt in the report of these observations, is derived from the order and succession in which they were made. A succinct account of the cases is first given; to this succeeds a summary of the observations concerning the formation and excretion of urea, and thereupon another summary concerning the liver and bile. A few general observations on the state of the blood make the transition to a somewhat fuller account of observations concerning the state of the epithelia and the parenchymata of organs. Interwoven with the accounts of the anatomical changes are short remarks on the relation which they may manifest with the symptoms during life.

(*b.*) *Abstracts of Cases.*

Collapse. No rally.

1. *Ellen Sage, æt.* 8.—This girl was admitted August 5th. She was vomiting and purging, pulseless, and in collapse. She had only been seized on August 5th without having had precursory diarrhœa. She died August 6th. The right lung was adhering all round its cavity, (which did therefore not exist,) and had to be dissected off the walls of the chest. It contained a few old dry tubercles; in its middle was one dense spot and more blood than usual. The left lung was free, contained also one dense spot in the middle. The lungs were inflated, and not heavy, but did not collapse. The heart contained a little blood on both sides and a fibrinous clot stretched into each artery, pulmonary and aorta. The stomach was full of green bloody fluid. There were many hundreds of minute erosions, from which the capillaries had discharged blood, which by the acid secretion of the stomach was changed to a green colour; but there were red flakes and some dark red blood present. The duodenum showed similar contents. Those parts where the bile duct and pancreatic duct enter were greatly inflamed and ulcerated. Many single glands were swelled. The jejunum, on the other hand, was filled with a light coloured pasty matter, which when mixed with water, would have made characteristic rice-water. The Peyer's patches were considerably raised over the surface, but not ulcerated. The ilium contained a darker greenish matter with many black flakes resembling the contents of the stomach. The Peyer's patches were raised enormously, and the vascularity of the intestine gradually increased towards the cœcal valve, in close proximity to which, within the cœcum there was an ulcer. The contents of the colon were very dark. The solitary follicles were considerably raised above the surface. The whole of the mesenteric glands were enormously swelled, and presented such a picture as is more frequently seen in chronic tuberculosis than in acute disease; the spleen was somewhat hard; the kidneys healthy; the suprarenal bodies, however, were somewhat abnormal; the blood was dark coloured, uniformly red, mostly fluid, but tenacious, and in the spectroscope showed the usual blood-bands. Examined chemically, the blood yielded an extract, which, with nitric acid, yielded some urea

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(Chem. Rec. H. 5).* But a second extraction furnished only a score of crystals, so that it remained doubtful whether there was any urea contained in them, (Chem. Rec. 2). The alcoholic extract of the chest and abdomen, after standing 20 hours with some nitric acid, deposited long crystals of urea nitrate (Chem. Rec. 16). The second alcohol and ether extract of the organs yielded some crystals, which were found not to be urea (Chem. Rec. I. x.).

Collapse. Reaction. Death. Clinical notes.

2. *John Beaumont*, 30.—Sugar baker, was admitted on August 1st at noontide. He had had diarrhœa for one day before; in the morning of August 1st, while at work, he was suddenly seized with cholera symptoms, cramp, and collapse, and on entering the hospital was pulseless. He was placed into a warm bath, and liked it as it stopped the cramps, restored the pulse, and seemed to put him into a state of reaction. From the 4th to the 6th he lay quiet and sleeping, and on that day died quietly.

Post-mortem examination.

The lungs were fully inflated. The heart was opened from the apex, and while drawn upwards the blood was ladled out of its cavities. The left ventricle contained a little fluid blood; the left auricle and the pulmonary veins were found full of blood. The whole blood ladled from the left side amounted to upwards of 6 ozs. The right ventricle was then opened similarly and found to contain a fibrinous clot, which had evidently been formed during the agony, and was prolonged by long branches through the auricle into the pulmonary artery. Besides the clot the right auricle contained but little blood. The entire heart was then cut out, and the blood which flowed from the main vessels collected in the cavity. It was found that the aorta was full of fluid blood. In this case the great arteries contained much more blood than the great veins.

Chemical examination of blood and organs.

The blood was extracted by alcohol and ether in the usual way, and yielded a great mass of urea nitrate crystals (Chem. Rec. 38). Some urea nitrate was also obtained by a second extraction (Chem. Rec. I. 6). The chest and abdominal organs were extracted three successive times; the first extraction yielded urea, the second less, the third a trace (Chem. Rec. I. 3, 9, y.). The muscles were extracted with water; the watery solution, after neutralization by baryta-water and filtration, was evaporated, and the residue extracted with ether and alcohol; urea nitrate was obtained (Chem. Rec. I. 13). A second extraction of the muscles with cold water yielded a little urea nitrate (Chem. Rec. 43).

Collapse. Death after 12 hours. Trace of urea in blood. Clinical history.

3. *Lucy Rigby*, 26.—Clinical history. Was admitted on August 15th. Had been seized with diarrhœa on the morning of the 14th, but it left her in the middle of the day and she went to bed as she believed quite well. At 2 a.m. of August 15th, she was seized with cramps in her legs, vomiting and purging came on and continued until admission, when her surface was cold, and no pulse could be felt; her eyes were sunken, her surface livid, and her aspect choleraic. She died at 4 a.m. of August 16th.

Post-mortem examination.

The post-mortem examination was made on August 16th. The rigor mortis was well marked, the eyes sunken, features wrinkled. The right side of the heart contained $6\frac{1}{2}$ ozs. of blood, the left $1\frac{1}{2}$ ozs. There were some small ecchymoses on the back of the left auricle. The right lung weighed 11 ozs., the left 9 ozs.; they did not contain much blood. In the back of the right apex there was an old cavity of the size of a walnut. The liver was soft and a little fatty. The gall-bladder was moderately full of thick bile. The kidneys weighed

* The abbreviated references between brackets are to the Chemical Records of the Pathological Laboratory, St. Thomas's Hospital.

and large intestines also contained a good deal of calomel, with about two quarts of greyish rice-water. The greyness was caused by the influence of the alkaline rice-water upon the calomel. The mucous membrane was very pale; its solitary glands rather more prominent. The bladder was quite empty and contracted. The blood of this body $7\frac{1}{2}$ ozs. together; the cortices were pale; the medullæ congested. Spleen and pancreas showed no anomaly. The stomach contained a large quantity of creamy semi-fluid matter, settling to the bottom of a good deal of greyish rice-water. The deposit consisted of calomel, of which she was stated to have taken 300 grains in 18 hours. The small was examined, the whole of the 8 ozs. being used by the usual method. The extract yielded no crystals at first, but after standing 24 hours a few small well-shaped needles of urea nitrate separated.

Blood contained a trace of urea.

Clinical notes. Collapse. Feeble reaction. Death. Much urea in blood.

4. *Jane Turnbull*, 44.—A married woman, was admitted on August 6th. She had had three days of diarrhœa, and on August 5th went to bed pretty well; but at 1 a.m. of August 6, vomiting, purging, and cramps in legs came on; her lips were livid, and she was in deep collapse. In this she continued, with hardly any recovery. For two days her temperature was much below normal, but during the last 12 hours it steadily rose to almost normal height (*see* Clinical Abstracts with Temperature Tables). She died August 15th. The left lung weighed $14\frac{1}{2}$ ozs., the right 10 ozs. There were old strong adhesions over the whole back and front of lower lobe, and part of the posterior aspect of upper lobe of left lung. The same was observed over the front of lower lobe, and the lower part of the back of the same lobe of the right lung. The left lung was emphysematous. All three lobes of right, and two lobes of the left behind, were strongly adherent to one another. The lower lobes of the left lung were crepitant on surface, but almost not crepitant over a large patch in the interior. This patch was rough and of a flesh-red colour, and somewhat granular as in pneumonia. No pus, but frothy mucus exuded abundantly from the small bronchi on section. The right lung was more emphysematous than the left, especially in the upper lobe. A patch of non-crepitant and collapsed tissue in the middle of lower lobe did not reach to the surface; it was hardly more red than the rest of the lobe. Both lungs contained a moderate quantity of blood. The left ventricle of the heart was contracted and nearly empty when opened; but the left auricle, pulmonary veins, and aorta admitted of the collection of 6 ozs. of blood taken by means of a spoon out of the left cavity. A moderately large pale clot extended into the aorta, and bore the marks of the semilunar valves. These valves were thickened at the edges and in their substance, and there was puckering at the junction of two of them. One had small apertures near the margin, forming a sort of fenestrated valve. On the inner curtain of the mitral valve were some small patches of atheroma. The aortic arch was considerably dilated. The right side of the heart contained 4 ozs. of blood. A firm pale clot occupied nearly the entire right ventricle, being closely adherent to the chordæ tendineæ, and stretching into both venæ cavæ, and also into the pulmonary artery, and bearing the moulds of the semilunar valves. On the upper part of the left ventricle were a few spots of ecchymosis. The liver was congested, its ducts contained some yellow bile, by the side of a cheesy yellow substance. This matter, which filled the ducts like a system of casts, was seen in all the ducts cut into, and extended along the common duct quite to its orifice. A portion of such a cast was examined, another preserved in spirit. They were of the structure and nature of the casts of the biliary ducts described in my treatise on gallstones. The gall-bladder was very much distended with nearly colourless bile. The

Post-mortem examination.

stomach showed moderate congestion of cardiac end of lesser curvature, and contained about 4 ozs. of brownish liquid, like beef tea. Small intestines not much altered. Peyer's patches less prominent than usual, and pale. The contents of the small intestine were semifluid, and much coloured with yellow bile. The large intestine was apparently normal, and contained a moderate quantity of semifluid yellow fæcal matter. The bladder contained a few ounces of urine. The brain was apparently healthy in every part, and not more than usually vascular. The mesenteric glands were normal in size, and the pancreas healthy. The suprarenal bodies were apparently healthy. At the beginning of the examination the rigor mortis had not set in, but at the end of the dissection the body was stiff.

It is not probable that the disease of the valves of the heart and aorta was of choleraic origin, and the casts of the bile ducts also seemed of older date. The case is, therefore, one of complication of cholera with chronic textural disease. The protracted nature of the case, and the continued lowness of temperature, point in the same direction.

Urea obtained from the blood.

The 10 ozs. of blood collected from the heart yielded an extract, from which nitric acid precipitated 1·203 grammes of urea nitrate. The urea amounted therefore to, at least, 0·586 grammes.

Collapse. Pregnancy at full term. Death. Butyric acid in rice-water.

5. *Martha Brooks.*—This patient was a stout, well-shaped woman in the ninth month of her pregnancy. I am not informed whether she was primipara, or had had children before. She died on August 10th, after a short illness, in deep collapse ; ten minutes after her death, the child, a fully and well-developed male, was removed by Cæsarian section, but was found dead. The post-mortem examination of mother and child was made on August 11th. The left side of the heart contained 14 drachms of feebly-curdled dense blood ; the right side contained 6 ozs. of clotted blood. The lungs were found gorged with dark blood and highly œdematous, so that masses of fluid could be pressed out of their substance. The stomach was fully distended with rice-water fluid ; the whole of the intestinal canal, including the colon, was filled with the same characteristic fluid, the only difference being that the upper parts contained a quantity of floating oil, being castor-oil administered to the patient. The contents were all carefully collected in bottles ; 8o zs. of the fluid contents of the colon were given to Dr. Sanderson for infection experiments ; the rest was taken to the Laboratory for analysis. This rice-water exhibited the peculiarity of all rice-water in a marked degree before a number of spectators in the dead-house. It developed such an amount of gas in a few minutes as to lift the glass stopper of the bottle in which it was contained before the eyes of all whose attention has been drawn to the phenomenon. The intestines were greatly congested with blood, and presented an additional feature which I have never before observed in any intestine. When a certain length, say a yard, of the intestine was allowed to hang down freely it remained an open tube, the sides not collapsing against each other, but standing out, as if the gut was forcibly filled with air. The intestine was, however, open, and was filled with air only by its own resiliency, so that the conclusion was forced upon the spectator, and immediately confirmed by his touching the intestine itself, that its walls were immensely thickened and swelled out so as to resemble boiled tripe, and to gain a springiness which was not natural to them. The gall-bladder was as usual gorged with bile. With the rice-water some infection experiments upon mice were made. But most important was the discovery in this rice-water of a quantity of butyric acid, and of the fact that the gas evolved from it consisted of a mixture of nitrogen and carbonic acid.

Post-mortem examination.

Chemical examination. Rice-water contains butyric acid, and yields nitrogen and carbonic acid.

In its totality no less than in its single features the above case is one of the most striking instances of cholera fatal in the shape of collapse that can be witnessed. The quantity of matter removed from the stomach and intestine was upwards of $3\frac{1}{2}$ pints, every portion of which presented the distinctive character of rice-water.

Chemical examinations of blood. No urea.

The blood obtained from the heart of this patient was subjected to chemical examination in the usual manner, and no trace of urea was obtained (Chem. Rec. 12). The rice-water obtained from the intestines was in part subjected to dialysis; an acid dialysate was obtained, which, being saturated by baryta-water to neutrality, was evaporated and extracted with alcohol and ether. No urea was obtained, but much butyric acid was set free by the nitric acid (Chem. Rec. I. 4).

6.—*Examination of the fœtus extracted from the foregoing case.*—The stomach of the fœtus contained a little fluid and epithelium. The small intestine contained half a drachm of soft mucous matter, which flowed out by gravitation when the intestine was held perpendicularly. The colon contained meconium of ordinary appearance, and in the ordinary quantity. The lungs were covered with numerous minute extravasations, appearing like fleabites. The kidneys were pale; the suprarenal bodies contained a large amount of extravasated blood each; the urinary bladder was filled with fluid.

Collapse passing into reaction.

7. *Elizabeth Townsend*, 16.—She was a single young woman; her mother was ill with diarrhœa. She herself had no prodromary diarrhœa, but was on the day of admission (August 11th) seized with purging, vomiting, and cramps; her surface was cool and she had no pulse at the wrist; she was placed in a bath, and there recovered her pulse, and was relieved; after that she lay in an apathic state, without either vomiting or purging, and died on August 12th at 8 a.m. Her temperature remained throughout nearly normal.

Post-mortem examination.

At the post-mortem examination the rigor mortis of hands and arms had passed, that of the lower extremities remained; the lungs collapsed entirely when the chest was opened. The right lung weighed 10 ozs., the left 11 ozs.; both were congested behind, but anteriorly anæmic, of doughy feel, slightly crepitant. The substance of the heart was very flabby, with pale patches of degenerated tissue, and easily broken up; the coronary veins were distended with blood. On the outside of the right ventricle, and at the base of the auricles, were numerous and extensive extravasations. The right side of the heart contained $5\frac{1}{2}$ ozs. of dark clotted blood, and a large pale fibrinous clot; the left side contained $1\frac{1}{2}$ ozs. of dark soft clot, and a large pale clot also. The brain was much congested. The cortical substance of the kidneys was much congested; some of the infundibuli of the pyramids contained a creamy matter. The liver was pale, and weighed 2 lb. 4 ozs.; the gall-bladder contained about $1\frac{1}{2}$ ozs. of dark green bile. The interior of the urinary bladder was covered with a layer of a thick yellow cream-like substance, similar to that found in the kidneys; this was a mixture of loose bladder-epithelium and pus, neither of which had been touched by urine, which remained suppressed till death. To this suppression the accumulation of the white matter in the pelvis of the kidneys, consisting of renal epithelium and pus, also owed its origin.

Blood contained a trace of urea.

The blood of this body was chemically examined; the extract yielded a very few crystals of nitrate of urea, and after standing 48 hours a few larger ones separated.

Clinical account.

8. *Charles Robson*, $2\frac{3}{4}$ *years.*—Admitted August 6th, with severe purging, sunken eyes, and small and rapid pulse. Soon bronchitic symptoms supervened, which produced death on August 14th. This child's mother was seized on August 4th with cholera, and died on

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August 6th in coma, after many bloody stools. This increases the probability that the bronchitis of C. R. was after all only a sequel of true cholera.

Reaction with destruction of lungs.

Some urine from this patient was found and examined after death.

Post-mortem examination.

The body was pale and warm, the rigor mortis well marked, the eyes sunken. On opening the chest the lungs collapsed, and sank considerably away from the front. On opening the pericardium the right side appeared considerably distended, the ventricle being flaccid. The left ventricle and auricle were firmly contracted. After about $1\frac{1}{2}$ drachms of clear fluid had been removed from the pericardial cavity, the blood was ladled out of both sides of the heart, the left yielding 2 ozs., the right side 1 oz. The right lung weighed $2\frac{1}{2}$ oz., the left 2 oz. Towards the base of the right lung a patch of hepatization of the size of a walnut existed, which entirely sank in water, and readily broke down on pressure, whilst purulent fluid was forced out of the small bronchi. The rest of the lower lobe was crepitant, and of a pale colour when incised, but the cut surfaces quickly became red. The entire middle lobe sank in water. It was of a greyish pink colour on section, and readily broke down on pressure with abundant effusion of purulent fluid. The upper lobe was slightly congested, and crepitant except at the anterior margins, which were carnified. From the rest of the lobe pus exuded on pressure. Of the left lung the upper lobe was non-crepitant except at the anterior margins; it was collapsed, but could be filled with air. The lower lobe, with the exception of a collapsed piece at the side of the size of about a hazelnut, was crepitant, and on section showed a pinkish colour, which soon became deep red. The intestines were considerably distended with gas; the stomach and small intestines were nearly empty; the large intestine contained some yellow matter. Peyer's patches were much congested and slightly raised, more in the upper than the lower part of the ilium. The mesenteric glands were large and pale. The spleen had a dark colour and was very firm. The gall-bladder was distended with an almost colourless fluid. The urinary bladder contained a little urine, of which a special observation was recorded. The brain was firm and to the naked eye not anomalous. A considerable quantity of subarachnoid fluid was observed.

Little urea in blood.

The blood of the foregoing case was examined, but its extract yielded no immediate precipitate with nitric acid. On standing for 24 hours, however, crystals of nitrate of urea of large size separated (Chem. Rec. 7). The cerebrospinal fluid gave an extract, which yielded a few crystals of rhombohedric shape, after standing for two hours with some nitric acid (Chem. Rec. 13). The colourless fluid from the gall-bladder contained much mucus, which was removed by filtration. Treated with Pettenkofer's test it yielded no purple reaction. The specific bile acids were absent as well as the colouring matter. The fluid was tested for albumen, but nitric acid caused only a milkiness, which on boiling contracted to a slight precipitate; boiling alone produced no reaction.

Little in cerebrospinal fluid.

Examination of fluid from gall-bladder.

Clinical notes.

9. *William Davis*, 5.—The son of a shoemaker, admitted August 2nd. Had been vomiting and purging for 24 hours, but had no cramps. Had no pulse, and was cold and livid. He continued in a heavy sleepy state, from which no stimulants revived him. Gradually sinking, he died on August 9th.

Post-mortem history.

This body was kept for four days before a post-mortem examination was made. I therefore did not subject any parts to chemical inquiry, decomposition being so far advanced that the body was turning green. The right lung weighed $3\frac{1}{2}$ ozs., the left $2\frac{1}{2}$ ozs. In the lower lobes of both lungs there were patches of recent pneumonia, surrounded by congestion; in the bronchial tubes was much pus. The right heart con-

tained $\frac{1}{2}$ oz. of blood, and a small pale clot; the left ventricle was firmly contracted over a firm pale clot, and the auricle contained $\frac{1}{2}$ oz. of blood. The liver was pale but congested in the dependent parts. The gall-bladder contained about $\frac{1}{2}$ oz. of dark thin bile. The intestines were slightly congested throughout, and contained a large quantity of yellowish bile-stained fluid. The kidney-capsules were easily detached, the cortex was pale, the pyramids congested.

Case of collapse.

10. *William Berry.*—Of this case no clinical notes appear on the hospital record at my disposal. The right side of the heart contained 8 ozs., the left $2\frac{1}{2}$ ozs. of blood. The lungs weighed, left 14 ozs., right $16\frac{1}{2}$ ozs. Both were intensely congested, especially their lower lobes, but crepitant throughout. Liver and kidneys were congested but otherwise apparently healthy. The intestines contained two pints of thickish opaque rice-water fluid.

No urea in organs.

The organs yielded no crystals of urea (Chem. Rec. 9, *also* 15), a second extraction with same negative result. The brain yielded a little matter which behaved like urea, but it was mixed with mineral matter, and the nitrate in it amounted but to a trace.

Collapse. Death. Little urea in blood and organs.

11. *Eliza Walker*, 20, *single.*—Was admitted August 9th, and died the same day. The heart was opened from apex towards basis; the left auricle, ventricle, and beginning of pulmonary veins contained 3 ozs. of black slightly-clotted blood; the right side contained $6\frac{1}{2}$ ozs. The lungs were not collapsed and weighed, the right 11 ozs., the left one 9 ozs. The right one was slightly congested at back of apex. The lower margins were not much congested; on its front were very pale patches. The left lung was considerably congested at apex and upper lobe, the lower lobe and the back were anæmic. The anterior margin of upper lobe did not crepitate. The small intestines were full of light brownish, very liquid rice-water. The large intestines contained a small quantity of thick creamy matter. The stomach and duodenum contained a moderate amount of thickish rice-water. The solitary glands were remarkably numerous and prominent throughout the intestine. In the left labium was an old cystic tumour containing clear fluid. The rice-water contents of the intestines were in part used for infection experiments (*see* No. 1, Mice Infect. Exp. Rec.). The organs were examined for urea, and a trace of it was discovered in the ether and alcohol extract of the alcoholic extract. The blood also yielded a quantity of nitrate of urea, sufficient to identify it.

Rice-water contents used for infection experiments.

Some urea in organs and blood.

Death in collapse, or shortly after.

12. *Hawkins.*—The post-mortem examination was made on August 25th. Both sides of the heart contained fluid blood. There was a pale clot of the size of a bean in the left ventricle. The left side of the heart contained 2 ozs. of blood, and the right side exactly the same quantity. The tissue of the heart appeared healthy and without any ecchymoses.

The right lung weighed 15 ozs. and was congested throughout, but normally crepitant. The blood stagnated most in the dependent parts, but even an emphysematous upper portion was congested. The left lung weighed also 15 ozs., and was universally adherent, indeed, so fixed to the diaphragm that a piece of this latter had to be cut out; the apex contained in many places cretified tubercles of the size of peas; around these there was consolidation; the rest crepitated normally. The intestines from stomach to rectum contained very much rice-water fluid, that of the stomach being slightly browner than that lower down. The mucous membrane was pale and sodden; the solitary glands well marked; near the cœcum were scars of two large ragged ulcers of old date. The mesenteric glands were apparently healthy. The liver was congested and weighed 2 lbs. $3\frac{1}{2}$ ozs.; the gall-bladder contained $\frac{1}{2}$ oz. of

bile. The kidneys were congested, showing a few stellate veins; in the bladder there was 1 drachm of milky fluid. The organs on extraction yielded no urea (Chem. Rec. 4). The extract of the muscles also yielded no immediate precipitate with nitric acid, but on standing for 24 hours it deposited large crystals of urea nitrate (Chem. Rec. 8). The brain yielded an extract, which, with nitric acid, yielded some crystals, but it remained doubtful whether they were urea nitrate (Chem. Rec. 26). The organs, after exhaustion with alcohol, were extracted with water, but no crystals of urea were obtained (Chem. Rec. 27). The intestinal canal yielded a trace of crystallized matter, but it remained uncertain whether this was urea nitrate (Chem. Rec. 31). The blood also was extracted for urea, but it was found not to contain any (Chem. Rec. I. 4).

Post-mortem examination.

13. *William Colley, died August* 24.—The right side of the heart contained $3\frac{1}{2}$ ozs. of blood; a large, pale clot filled the right ventricle, extending into the pulmonary artery. The left side of the heart contained $2\frac{1}{2}$ ozs. of blood, and a soft dark clot in the ventricle extending into the aorta. The right lung was adherent with its base to the diaphragm, where there was a white scar, from which white lines passed radially; near this were several large ecchymoses. The whole lower, and middle, and lower part of upper lobes in a state of lobar pneumonia, without any marginal patches of pneumonia. The whole pneumonic part was soft, easily breaking down on pressure, and exuding abundant puriform fluid. The right lung weighed 1 lb. 13 ozs.; the left weighed $13\frac{1}{2}$ ozs. and was adherent by old bands, which could be broken with moderate ease. On the costal surface of lower lobe was a large scar like that of the other lung, near which were patches of ecchymosis. The anterior surface of lower lobe was nodular, and these nodules were sometimes congested, sometimes emphysematous, but never pneumonic. In the middle of the upper lobe there was one patch of circumscribed pneumonia of the size of two walnuts, exactly like the lobar pneumonia of other lung. The liver was healthy; the gall-bladder contained a moderate quantity of brownish yellow bile; the kidneys together weighed 16 ozs.; the cortex was pale; the medulla congested; the stellate veins were moderately plain; the spleen was small; the stomach contained a considerable quantity of thick creamy fluid; the small intestines contained some of the same consistency, but rather yellower colour, and much flatus; the large intestine contained a little fluid and much flatus; the bladder contained $10\frac{1}{2}$ ozs. of urine of normal colour.

The cerebrospinal fluid of this man was collected and analysed. It yielded a mass of crystals of urea nitrate (Chem Rec. 6). The brain was also extracted, and the liquid obtained became a solid mass of urea nitrate, on addition of nitric acid. This weighed 0·545 grammes, equal to 0·265 grammes pure urea (Chem. Rec. 20). The muscles of this man also yielded in their extract a great mass of urea nitrate crystals immediately on addition of HNO_3 (Chem. Rec. 32).

Cholera. Death in reaction.

14. *Abraham Devonport, æt.* 48.—Died in reaction on August 19th, and his body was inspected the same day. The left side of the heart contained 4 drachms of blood, the right $2\frac{1}{2}$ ozs. The lungs were both extremely congested, but crepitant throughout; they were both heavy, especially the right, but not anywhere consolidated. The liver was healthy-looking, but the gall-bladder was extremely distended with thin bile; the intestines had also an almost normal appearance and contained yellow semifluid matter. The thoracic and abdominal organs of this man were examined for urea; from the first alcohol extract 0·124 grammes of nitrate, equal to 0·06 grammes of free urea, was obtained

(Chem. Rec. 29). The water extract of the same organs yielded yet much nitrate of urea (Chem. Rec. 30). A third extraction yielded some groups of well-formed crystals (Chem. Rec. 41).

Death in reaction.

15. *Mary Anne Hayward*, 46, *single.*—Died August 19th in reaction. The post-mortem examination was made 24 hours afterwards. The left heart contained a clot in the ventricle, auricle, and pulmonary veins, which together with the fluid blood around made up $2\frac{1}{2}$ fluid ozs.; the right side contained two large white fibrinous clots, and altogether $3\frac{1}{2}$ ozs. of blood. The right lung weighed 1 lb. $4\frac{1}{2}$ ozs., and was congested everywhere, except at the anterior margins. The entire middle lobe, excepting its anterior surface, was consolidated with pneumonia; its colour was reddish grey, and pus in abundance exuded from the tissue on pressure. The apex contained a number of small calcareous nodules. The left lung weighed $11\frac{1}{2}$ ozs.; its anterior surface was pale, its back congested; its apex also contained calcareous nodules. The liver weighed 2 lbs. 14 ozs.; the gall-bladder was immensely distended with dark green bile. The stomach appeared normal; the intestines were filled with fluid contents, suggesting want of absorbing power. In the large intestine, 18 inches below the ileo-cœcal valve, was a cicatrix of an old ulceration of the size of a shilling; this had a dark reddish-brown margin, with puckering spreading radialy from it. The capsule of the right kidney was adherent in two or three small patches; the left was healthy.

Blood contained urea, organs also.

The extract of the blood of this person gave many needle-shaped crystals of urea nitrate (Chem. Rec. I. 1); a second extraction yielded some more urea (Chem. Rec. 7). From the organs a quantity of well-formed crystals was obtained only after many hours standing (Chem. Rec. 36).

Cholera. Collapse without rice-water purging. Death.

16. —— *Simmonds*, 26.—This patient died after 8 hours illness on August 26th, without having had, as was alleged, any rice-water purging. The post-mortem examination was made 15 hours after death. The rigor mortis was well marked, the body yet slightly warm. The right heart was very full of fluid blood, with a small partly decolorized clot; indeed so great was the distension of the right ventricle that it formed the apex of the heart by itself, while the left heart was firmly contracted and contained very little blood. The left lung weighed $14\frac{1}{2}$ ozs., the right one $16\frac{1}{2}$ ozs. They were pale in front, but on sections several large clearly circumscribed patches of what was either intense congestion or interstitial extravasation were observed, in which crepitation was only diminished, not absent. The back of both lungs was congested. The liver weighed 2 lb. $14\frac{1}{2}$ ozs., was of a dull colour, and its lobular markings were very indistinct. The kidneys separated readily from their capsules. The cortex was somewhat pale; the medullary portion congested. The bladder contained a drachm of turbid fluid. The stomach contained more than a pint of fluid, greyish matter, mixed with small black patches, apparently blood, changed by acidity; its membrane looked very pale and sodden. The small intestines were full of pale rice-water fluid, their mucous membrane was pale; the solitary glands and Peyer's patches were moderately prominent. The large intestine contained a very little thick creamy matter of pale colour.

The extent of a portion of the muscles of this subject yielded no immediate precipitate with nitric acid, but on standing several hours, many long well-shaped crystals of urea nitrate separated. The extract of the organs of the chest and abdomen yielded a few crystals (Chem. Rec. 17, 21).

17. *Olyfes Nelson*, 33.—(*See* Clinical History amongst Temperature Observations.) The body was examined some hours after death; it was

APPENDIX.

No. 10. *On Cholera chemically investigated by Dr. Thudichum.*

yet warm and the rigor mortis had not set in. The right heart contained 15 ozs. of blood, the left side 4 ozs. There were no ecchymoses on the heart. The lungs adhered slightly to the pleuræ. The left lung weighed 15½ ozs., the right 16½ ozs. The upper lobes of both lungs were emphysematous, especially their exterior parts, and very anæmic on section. The backs of the upper lobes, the right middle lobe, and the lower lobes were in the following condition :—Distributed throughout their substance were hard nodular patches, and the whole of the tissue surrounding these was of dark red colour, and soft and rotten like tinder. Of the patches some were in a state of red hepatisation, others advancing to grey; at the apex was a patch almost white, where the tissue was soaked with pus ; all patches on pressure yielded spots or little streams of pus. The kidneys were large and their capsule readily stripped off. The stellate veins were not well marked ; the cortex was pale ; the cones congested. The spleen was small and firm. The cardiac end and greater curvature of the stomach was intensely congested. The duodenum and small intestines were moderately congested in various places, but at intervals appeared almost normal. The large intestine was much congested throughout. The bladder contained about 4 ozs. of urine.

The internal organs of this man were examined for urea. A singular jelly-like mass was obtained, which effervesced with nitric acid, but no crystals were formed (Chem. Rec. 11). It is possible that the jelly-like mass desoxydized the nitric acid, and that the nitrous acid formed destroyed any urea, the products nitrogen and carbonic acid causing the effervescence. In every case where effervescence takes place, this possibility must be borne in mind.

The blood of the patient yielded an extract containing much urea, which on addition of nitric acid immediately formed a great mass of crystals (Chem. Rec. 24). In the dry state this weighed 3·318 grammes, equal to 1·618 grammes of pure urea. This is the largest quantity of urea that I have ever found, or learned to have been found by others, in the blood obtainable from the heart of a uræmic or any other patient. The hot water extract of the organs of this subject, which was made after the alcoholic extract, yielded much nitrate of urea (Chem. Rec. 42).

Death in collapse. A little urea in organs.

18. —— *Laskey.*—Of this case I have no clinical notes, but assume it to have succumbed in collapse. The organs of chest and abdomen were examined for urea, but none was obtained from the first or alcoholic extract. The hot water extract of the same, which was made after the alcoholic extraction, after evaporation and re-extraction in the usual manner, yielded a little matter, which though not giving an immediate precipitate with nitric acid, formed many well-shaped crystals after standing many hours (Chem. Rec. 5, 19). Another extraction yielded nothing ; and a fourth was equally without result (Chem. Rec. 22, 23). Another portion of the organs yielded a few crystals (Chem. Rec. 28).

Collapse. Death.

Chemical examination. Organs contained trace of urea.

Blood contained no urea,

19. *John Ribocq*, 66.—A short clinical record of this case is amongst the abstracts accompanying the temperature tables. He died August 20th, and his body was anatomically examined on August 21st. There were the usual appearances of the state of prolonged collapse. From the extract of the abdominal and chest organs a few crystals of urea nitrate were obtained, scarcely sufficient for identification (Chem. Rec. 14). These same organs were twice extracted with cold water, and yielded no crystals at all (Chem. Rec. 33, 37). The intestines were extracted separately and yielded no crystals whatever (Chem. Rec. 34). The extract from the blood yielded no urea crystals, but developed a strong smell of butyric acid (Chem. Rec. 39). This circumstance makes it

probable that absorption from the intestinal canal had begun, and that some ammoniacal butyrate formed in the cholera-fermentation of the intestine was already circulating in the blood.

but butyric acid.

20. *John Hammond*, 7.—This patient, of whose case an abstract will be found amongst the temperature observations, died on August 24th. Some of the cerebrospinal fluid was collected and analysed, but yielded no urea (Chem. Rec. 18). This was unexpected as the patient had had fits and anasarca, and therefore the existence of uræmia was probable.

Complicated reaction. Death. No urea in cerebrospinal fluid.

(*c.*) *Summary of Observations concerning the Formation and Excretion of Urea.*

(*c*) Summary of observations concerning urea.

It may be assumed that a chemical condition of the body in which urea ceases is to be formed is necessarily fatal. We know such a condition in malignant jaundice. Urea is there partially or entirely replaced by leucine and tyrosine, and the perversion of the chemical process almost always leads to death. Hence it may also be supposed that cholera cases in which the T was so low as to greatly diminish or arrest the formation of urea are also fatal.

No urea in bodies dead from early collapse. Very little in some cases.

In cases of death from rapid collapse little or no urea is found in the various parts of the body. Thus in the cases of Ribocq, Brooks, Berry, Laskey, no urea was found; in the cases of Sage, Walker, Rigby, and Townsend, traces or very minute quantities of urea were met with. In the case of Hawkins (a drunkard), the muscles contained some urea, but neither did the blood nor the organs. In the case of Simmonds a few crystals were met with.

More urea after protracted algid stage.

In cases which have continued for some time, 24 hours or upwards in the post-reactional algid, the torpid, stage, and have then died, a little more urea is found.

Much urea after three to six days' torpid condition.

In cases which have continued in the torpid from three to six days, great quantities of urea are collected in the body. The case of Beaumont is an apt illustration of this.

Greatest amount of urea found after long algid stage with rise of Temperature at the end.

Great quantities of urea are found in cases which have remained for more than six days in the torpid stage, and have died after a considerable rise of T (see case of Jane Turnbull).

Little urea eight days after collapse.

In cases which die later than eight days after lowest collapse, very little urea is found in the tissues, if the urinary secretion was established early in reaction. (Case of Robson.)

Much urea in cases of pneumonia and typhoid in brain and cerebrospinal fluid.

Great quantities of urea are found in cases which have for some time had secondary pneumonia and typhoid symptoms. (Case of O. Nelson.) In such cases, also, the cerebrospinal fluid and the brain contain surprising qnantities of urea. (Case of W. Colley.) Cases which died in reaction, so-called, yielded a little urea. (Devonport, M. A. Hayward.)

The rice-water yielded no urea.

Reasons for improbability that rice-water should contain urea.

The examination of rice-water, both freshly voided and taken from the intestine after death, yielded no urea. The method of research employed was so accurate, that had the merest trace of urea been present it must have been discovered. Three circumstances combine to make it improbable that the rice-water should contain urea. 1. The body at the beginning of cholera contains either no urea or only the usual traces. 2. The formation of urea is at once diminished with falling T. 3. Even if, against all probability, a little urea passed into the rice-water, its alkaline fermenting state and the decomposing mucine would probably quickly decompose it, and the products would increase the quantity of carbonic acid and ammonia present in rice-water. These theories fully explain the negative results of analysis.

Appendix.

No. 10.

Particular kidney lesion.

No dropsy.

When dropsy, no urea retained.

More urea may be excreted in tepid stage.

If after re-establishment of the urinary secretion urea accumulated in the body, we have to assume the existence of a particular kidney lesion. This kidney lesion is not accompanied with dropsy. (O. Nelson.)

On the other hand, there is a kidney lesion, sequel of cholera, which produces dropsy, and this is not accompanied with retention of urea in the body. (Hammond.)

I have no doubt that in the tepid or febrile stage, without kidney lesion, more urea may be formed than during health, as has been asserted by former inquirers. But no such cases have come under my observation.

(*d.*) *Special Account of the Chemical Examination of the Bile from the foregoing Cases.*

(*d*) Special account of the chemical examination of the bile from the foregoing cases.

The biles immediately after removal from the bladder were mixed with about an equal bulk of alcohol, and filtered, to remove the mucus. This in some cases was very copious, in others less; in a few cases it made the filtration so difficult that it lasted many days, and the fluid had to be transferred from filter to filter in order to purify it. Some of the filtrates deposited cholesterine in crystals, which were again removed. Others remained opalescent, and deposited more mucus and other insoluble matters after some standing. Ultimately, when the fluids had all become clear, they were one by one subjected to spectroscopic analysis, but no particular spectrum was found. The red and green were more vivid than usual; the blue almost extinct by thicker layers. The biles were now all arranged in a series according to their colour, the palest being the first, the darkest the last in order, and subjected to the following course of analysis :—

I. A portion of each was subjected to Pettenkofer's test, with sugar and sulphuric acid. In order to avoid all over-heating, the watch glasses and china dishes in which the testing was performed were placed upon snow. Each test was twice repeated upon equal quantities of material.

II. The biles which gave a negative or undecided result with Pettenkofer's test were subjected to further examination. They were boiled with animal charcoal, filtered, and to the now colourless solution a drop of acetic acid was given. The mixture was now boiled again, to precipitate any albuminous matters. Though no precipitate ever appeared, the solution was filtered as a precaution. The filtrate was evaporated to dryness on the waterbath, and then dissolved in a very small quantity of absolute or very strong alcohol. Upon this concentrated extract Pettenkofer's reaction was tried anew, and the result noticed. It was found that in most cases the primary test had been sufficient, inasmuch as the results, whether negative or positive, remained the same. In cases 7 and 11 only, in which the alcohol solutions were very dark coloured, and contained probably only small quantities of biliary acids, the decolorisation and concentration of the solutions was found to be of essential service.

III. The entire alcoholic solution of each bile was measured, and 20 c. c. of each evaporated to dryness on the waterbath, dried in the steam-closet, and the solid residue weighed. From this the total amount of solid residue in each entire bile, that is, the whole of the solid contents of each gall bladder, was calculated.

1. Charles Robson, æt. $2\frac{3}{4}$ years. The gall bladder contained a perfectly colourless fluid, which was freed from mucus by filtration. Treated with Pettenkofer's test it yielded no purple reaction, showing that the specific bile-acids were absent, as well as the colouring matter.

The fluid was tested for albumen, but nitric acid caused only a milkiness, which on boiling contracted to a slight precipitate; boiling alone produced no reaction.

2. Ellen Sage. Colour of solution pale yellowish greenish. The residue of evaporation was yellow, a little brownish. The whole of the fixed matters contained in the gall bladder weighed 2·1733 grammes. The original solution gave a dark straw-coloured reaction with Pettenkofer's proceeding, and a yellowish brown precipitate. The decolorised extract only gave a yellowish coloration. Consequently this fluid like that in case 1, contained no biliary acids.

3. Jane Turnbull. The alcoholic solution was pale greenish yellow, and contained 1·0612 grammes of solid residue. It gave the same straw-colour and yellowish brown precipitate as case 2. Its decolorised extract also gave simply a yellowish coloration, proving the complete absence of biliary acids.

4. William Colley. The solution was of a pale straw, urine-like colour, and left 1·1633 grammes of residue. With sugar and acid it gave a bronze-like coloration, with a yellowish red margin. The decolorised extract gave a reddish yellow coloration, and a turbidity of a similar tint. Consequently this fluid also was destitute of biliary acids.

5. John Beaumont. The solution was of a pale straw somewhat greenish colour, and contained 2·1660 grammes of solid matter. It gave a deep-purple coloration, and dark precipitate of similar colour. It consequently contained biliary acids.

6. — Laskey. Solution light greenish brown, and left a dark yellowish residue of 1·7629 grammes in weight. It yielded the test for bile-acid.

7. — Simmonds. Solution reddish brown, leaving 2·8636 grammes of yellowish brown residue. A portion of the solution gave a bronze-colour with the bile-test, which had a crimson margin. The decolorised extract gave a striking colour-test. The biliary acids were therefore present, although in small quantity only.

8. E. Walker. The solution was brown, left a brown residue 1·4470 grammes in weight, and gave the reaction for bile-acid readily.

9. — Hawkins. The solution had a dark reddish brown, in thin layers, greenish colour. It contained 4·6116 grammes of matter in solution, and left a greenish brown residue. It gave the reaction for bile-acid strikingly.

10. H. Hodges. The solution was brown, with touch of green, contained 3·3256 grammes of matter, which remained as a greenish brown residue, and contained a quantity of bile-acid.

11. E. Townsend. The solution was red, in thin layers green. Residue dark greenish brown, weighed 1·8197 grammes, gave a dirty yellowish brown colour test, with a reddish margin. As the first reaction was somewhat feeble a decolorised extract was prepared, which gave a good purple test. The amount of bile-acid was small.

12. Wm. Royle, æt. 17. The solution was brownish red, the residue dark brown, weighing 1·6876 grammes. The solution only gave a citron yellow coloration, no precipitate, and no particular colour at the margin with sugar and sulphuric acid. The decolorised extract also gave but a yellowish colour, but no bile-acid reaction. Consequently this fluid, *although highly coloured, did not contain any biliary acids.* It therefore constituted an exception to the rule exhibited by this series, that the amount of biliary acid and of colouring matter stand in a direct proportion to each other.

13. The bile of three cholera patients had been placed in one bottle. The solution was green and brown, its residue very dark green brown,

and weighed 6·2675 grammes. The solution gave a yellowish brown coloration, with a reddish yellow tint at the margin, considered a sufficient proof of the presence, in small quantity, of biliary acid.

14. Mary Ann Hayward. The green brown solution contained 3·0528 grammes of solid matter. It gave a citron yellow test, with a reddish yellow margin, indicative of a small amount of biliary acid.

15. Caroline McCarthy. Green brown solution, containing 4·4393 grammes of residue; gave a splendid colour test, without any precipitate.

16. Abraham Devonport. The brown green solution left a black green brown residue, 3·4072 grammes in weight. It gave a dark dirty yellowish brown coloration, and a similar precipitate. A decolorised extract gave a reddish yellow coloration, with a crimson hue at the margin, thus indicating the presence of just a trace of biliary acid.

17. J. Ribocq. Solution black green brown, leaves black green brown residue, weighing 5·0954 grammes. The solution gave a yellowish brown colour, with a crimson margin.

It is thus clear that the four palest specimens of fluid (1, 2, 3, 4), and one very dark one (12), did not contain any biliary acid whatsoever. Several others contained mere traces of biliary acid (7, 11, 13, 14, 15, 16); the rest contained biliary acids in the ordinary proportions apparently of healthy bile.

The biliary colouring matters, which by a generic name I designate as cholochrome, were absent in five cases. In four of these there was some colouring ingredient present, which gave to the bile a pale yellowish green, or straw or urine colour, but it was not of the quality of biliary colouring matter, and very slight in quantity. In case five the cholochrome was absent, while biliary acid was present. This case, therefore, is in a manner the reverse of case 12, in which, though biliary colouring matter was present, the biliary acid was absent.

The particular modification of cholochrome present in the biles Nos. 6 to 17 seems to have been bilifuscine, with some biliprasine, and in one case only bilirubine or cholephæine.*

(*e*.) *Summary of Observations concerning the Liver and Bile.*

No materials of liver function. Secretion of bile arrested.

The liver suffers primarily through the pabulum of its action being withheld, secondarily through the change in the composition of the blood. The earliest result of these changes is complete arrest of its function as exhibited in the secretion of bile.

A white watery fluid secreted.

In extreme cases a fluid still percolates through its ducts, but it is clear, white, free from biliary and colouring matter, and does not even contain any serum, being free from albumen; it is water with a trace of

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* I define as cholephæine or bilirubine that particular modification of cholochrome which colours the yellow or red bile. This substance is crystallisable, soluble in chloroform, insoluble in alcohol and ether, and has the formula $C_9H_9NO_2$, atomic weight 163. I have controlled this formula by a great number of analyses of neutral, basic, and half-acid metallic compounds, and am therefore enabled to declare as perfectly erroneous all the formulæ which Städeler has attributed to the various modifications of cholochrome. Biliverdine arises from bilirubine by oxydation and loss of carbonic acid, and is probably $C_8H_9NO_2$. It is green, and remains so in an ammoniacal solution. Bilifuscine, which was discovered by Städeler, is of a rich dark brown colour, soluble in alcohol, insoluble in chloroform. Its atomic weight is near that of bilirubine, as I have ascertained by the analysis of its lime-compound, and by no means near that assumed by Städeler. Biliprasine is a leek-green colouring matter, which in its ammonia solution is brown. Its analyses justify the assumption that it is a hydrate of biliverdine, and has the formula $C_8H_{11}NO_3$. (The atomic weights of the elements of the foregoing formulæ, C = 12, H = 1, N = 14, O = 16).

TABLE showing the CONDITION of the BILE of Nineteen Persons dead from Cholera.

No.	Names and Ages of Persons.	Colour of the Alcohol Solution.	Quantity of Solution in C.C.	Colour of Residue obtained by Evaporation.	Weight of Residue of 20 C.C. in Grammes.	Weight of all Fixed Matters in the Contents of each Gall Bladder.	Results of Tests concerning Cholochrome.	Results of Tests concerning Biliary Acids.
1	Charles Robson, $2\frac{3}{4}$ -	Colourless - -	10 C.C.	Colourless - -	- -	- - -	Absent - - -	Absent.
2	Ellen Sage, 8 - -	Pale yellowish green	188	Yellow, little brownish	0·2312	2·1733	Absent - - -	Absent.
3	Jane Turnbull, 44 -	Pale greenish yellow	111	Ditto ditto -	0·1912	1·0612	Absent - - -	Absent.
4	William Colley -	Pale straw urine colour	106	Ditto ditto -	0·2195	1·1633	Absent - - -	Absent.
5	John Beaumont, 30 -	Pale straw, little green	100	Ditto ditto -	0·4332	2·1660	Absent - - -	Present in small quantity.
6	—— Laskey - -	Faded greenish brown	75	Dark yellowish -	0·4701	1·7629	Present, bilifuscine -	Present.
7	—— Simmonds, 26 -	Reddish brown -	89	Yellowish brown -	0·6435	2·8636	Present, bilifuscine -	Present in very small quantity.
8	Eliza Walker, 20 -	Brown - - -	33	Brown - - -	0·8770	1·4470	Bilifuscine - -	Present.
9	—— Hawkins - -	Dark reddish brown in thick layers greenish.	84	Greenish brown -	1·0980	4·6116	Fuscine and prasine -	Present.
10	Henry Hodges - -	Brown, with touch of green.	54	Ditto ditto -	1·2317	3·3256	Present - - -	Present.
11	Eliza Townsend, 16 -	Red, in thick layers, green.	50	Dark greenish brown	0·7279	1·8197	Present - - -	Present in small quantity.
12	William Royle - -	Brownish red - -	62	Dark brown - -	0·5444	1·6876	Bilifuscine, perhaps rubine.	Absent.
13	Three cholera patients together.	Green brown - -	101	Very dark green brown.	1·2411	average in each 2·0891	Present - - -	Present in small quantity.
14	Mary Anne Hayward, 46.	Ditto - - -	106	Ditto ditto -	0·5760	3·0528	Fuscine and prasine -	Small quantity of biliary acid.
15	Caroline M'Carthy -	Ditto - - -	95	Ditto ditto -	0·9346	4·4393	Ditto ditto -	Present in normal quantity.
16	Abraham Devonport, 48.	Brown green - -	110	Black green brown -	0·6195	3·4072	Ditto ditto -	Only a trace of bile-acid present.
17	John Ribocq, 66 -	Black green brown -	146	Ditto ditto -	0·6980	5·0954	Ditto ditto -	Present.

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alkali and a vestige of mucus. (See the case of Robson, under analyses of bile.)

A coloured fluid secreted. No bile acids.

In another series of cases a fluid of a pale yellow colour is secreted, which is free from the specific bile acids, and does not contain normal colouring matter or cholephæine. (See the cases of E. Sage, J. Turnbull, and W. Colley, under analyses of bile.) Rarely a brown coloured fluid, free from bile acids, is secreted. (See case of William Royle, 12, under analyses of bile.)

Dilute bile in other cases. Bile after long reaction.

In most cases of cholera, where the above conditions do not occur, the biliary fluid is thin, contains traces to notable quantities of bile acids and brownish-green colouring matter. Sometimes, particularly after continued reaction, the gall bladder is enormously distended with such dilute bile. In one case I found more than six ounces. Much mucus and loose epithelium are also found in it.

Bile ducts shed their epithelium.

The bile ducts shed their epithelium, which may form casts,* if a coagulating material be also present.

Bile collects in cholera as in starvation.

It is not easy to explain why in many cases of cholera, particularly in the torpid and tepid stage, the bile collects in the gall bladder. Physiologically such collection takes place during periods of starvation. No doubt cholera patients are in a state of starvation. But their common duct is probably also less pervious; or the gall bladder itself, like the intestinal canal, is in a semi-paralysed state. In some few cases the quantity of bile is not increased, though its specific gravity is always low.

Bile may be retained from period before cholera.

The bile found in the gall bladder in early collapse cannot always be considered as secreted under the influence of the earliest symptoms of cholera. As in a few cases of urine in the urinary bladder, a little bile, retained from the period before the outbreak of cholera, may perhaps remain admixed with the new secretion, and thus give it a fallacious appearance.

(*f.*)—*Observations concerning the State of the Blood.*

Changes by loss.

The blood has lost water, albumen and salts, it is incapable of passing the capillaries with the necessary freedom, and of effecting secretions; it is incapable of absorbing and carrying the necessary amounts of oxygen and carbonic acid.

Hemochrome mostly unchanged.

The blood retains most of its colouring matter, hemochrome, in its normal chemical composition, as evidenced by the unchanged spectrum obtained in the spectroscope. It has been stated by Zimmermann that a portion of the hemochrome may be decomposed, and, on analysis, appear as hematine. But this decomposition, which I never observed in fresh cholera blood, was, perhaps, an after-death change. Zimmermann dried the blood by exposure to the air at the ordinary temperature, and thus probably obtained some ammoniacal decomposition in consequence of which some hematine became dissolved on subsequent extraction with alcohol. This change, whatever its significance, concerned only small quantities of hemochrome; the great mass remained unchanged.

Normal spectrum does not exclude fermentation.

The spectrum analysis of the blood alone, if it gives a normal spectrum, does not bear proof that the blood is not in a state of fermentation. For blood which has been allowed to putrefy during times

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* The most striking example of the shedding of the epithelia and clogging of the ducts was met with in the liver of Jane Turnbull, æt. 44 (case 4. of p.m. examinations, where special description of the casts; also, analyses of bile, case 3). But it may fairly be questioned whether these formations were results of the cholera; they may have existed before it.

varying from a month to five years, continues to show the normal blood spectrum. The most intense putrefaction is incapable of destroying the normal colouring matter of blood.

Appendix. No. 10. *On Cholera chemically investigated by Dr. Thudichum.*

Blood fermentation improbable.

It is not certain whether the blood or any part of it can be primarily fermented in the manner in which the intestinal contents are fermented. On the whole such a fermentation is very improbable. It is, however, certain, that fermentation products, such as those contained in rice-water, may at certain stages be found in the blood. The appearance of such fermentation products has always been subsequent to the period at which absorption from the intestinal canal has probably been resumed. Thus the butyrate of ammonia in the blood of Ribocq, and the rice-water smell of the breath of another patient, are probably due to absorption.

Blood absorbs water from tissues.

During the progress of the patient towards collapse, his blood absorbs all watery humours of the body wherever it can find any, and thereby restores its water in part, but also takes up heterogeneous elements at the same time. The most striking example of this absorption, its rapidity and amount, is afforded by the accident of a dropsical patient being seized with cholera. The dropsy disappears in so magical a manner that the patient feels thankful to the new disease as a curer of the old one.

Blood furnishes a derivate of hemochrome to first urine.

The choleraic urocyaninogene, and the urorubinogen, which will be more closely examined under the disquisition on cholera-urine, are by some supposed to be derivates of hemochrome. We shall see that the spectra of the blue and red products of decomposition of these bodies resemble the spectra which can be obtained in artificial derivates of hemochrome in several important particulars.

No chemical evidence of special cholera poison in blood.

There is no chemical evidence of the presence in the blood of any particular cholera poison. It must, however, be admitted that the blood is not yet so exhaustively examined as to justify the positive denial of the existence of such a poison.

Changes in the red corpuscles.

The red blood corpuscles in collapse appear to be in part more resistant against the effect of water.

White bodies augmented.

The colourless corpuscles are sometimes increased in numbers. They quickly become granular, and on addition of water, more clearly on addition of acetic acid, exhibit one or several nuclei.

Admixture with blood of epithelium of vessels.

The epithelium of the inner surfaces of the blood vessels, particularly arteries, becomes here and there detached, and mixed with the blood. In many smaller arteries where the pulse ceases during collapse, accumulations of such cells can be found, *e.g.* in the radial artery. Possibly the minute extravasations of the surface of the heart of young individuals, and in the brain, perhaps also the capillary stagnation of other parts, is in part caused by direct obstruction of the capillaries by such detached intravascular epithelium.

Blood more adherent to blood vessels.

The blood adheres to the blood vessels more pertinaciously, not only because it is thicker, but also because the surfaces of the vessels are changed, particularly after the lowest collapse has passed over.

(*g*.) *Observations concerning the State of the Epithelia.*

Tongue.

The epithelium of the tongue is shed in collapse, and mostly quickly removed. The tongue has, therefore, a foul or fevered appearance, more commonly at an early stage and after reaction; I have seen several cases in which the tongue was raw looking, and on close inspection showed the papillæ not covered by any exfoliating surface of epithelium.

Salivary glands.

The functions of the salivary glands are arrested, and the epithelia of their excretory ducts cast off. The nuclei of the limitary membrane immediately multiply, and pus corpuscles are produced. When the collapse

has been low, the temperature of the body greatly reduced, and the shedding of the epithelia in the ducts has been massive, the glandular substance itself participates in the process. The cells of the acini produce a great number of nuclei, which soon transform into pus cells. The gland now swells and œdema and inflammation ensue all round. Thus parotitis on one or both sides ensues, which requires surgical aid. It mostly ends in death. (See Hammond's case.)

Parotitis.

Lacrymal glands.

The lacrymal glands become similarly obstructed. No tears are secreted during the period of collapse. Pus soon oozes from the lacrymal ducts, and with the epithelia from the cornea and conjunctiva collects as a mass of thick dryish yellow matter in the corner of the eye.

Cornea ulcerated.

The cornea being dry, and during the comatose condition following collapse exposed to air and superficial desiccation by the persistent gaping of the eyelid, casts off its epithelium, and sometimes becomes superficially gangrenous in the part most exposed and exsiccated. The severe ulceration may lead to the loss of sight. It occurs most commonly in young children.

Epithelia of nasal cavity.

No sneezing in collapse.

The epithelia of the nasal cavity also die off, but owing to the absence of secretion are not discharged before reaction has proceeded some time. Their death assists mainly in causing a perfect want of irritability in the nose during collapse, so that many patients cannot be made to sneeze by any irritant. The nose does not feel the irritant, does not smell, as the tongue burned by hot fluids does not taste the varieties of food.

Cylindric epithelia of trachea.

Rarely bronchitic irritation as cough.

The cylindric epithelium of the trachea and bronchi is also affected, though less than the alveolar portions of the lung. There is mostly an absence of bronchitic irritation as exhibited by coughing, though the bronchitic signs may be presented to physical diagnosis. In tepid reaction bronchitic cough may appear. I have, however, never been able to observe any specific sputa.

Changes in lung-cells.

Pus in lung tissue.

The nuclei which lie distributed in the walls of the lung-cells frequently begin to multiply, and to produce masses of pus. This pus is mostly distributed in the tissue until death, and rarely evacuated into the air-passages. On cutting into the lung so affected pus oozes out of the surface on pressure. This is a condition differing from all other lung diseases (except some forms of influenza), and particularly differing from pneumonia. The tissue infiltrated with pus is mostly still crepitant, though denser and more congested, and sometimes in small portions hepatized. But it has the appearance of the absence of any fibrinous exudation.

Lung power permanently damaged. Death caused.

The effect of this change in the lung-cells is enormous. Perhaps no person, recovered from extreme cholera, fully acquires his former lung-power. Many remain seriously damaged, many die of this particular lesion. Respiration, as shown by chemical analysis of the in and expired air, is greatly diminished; the circulation cannot pass on; the blood gets vitiated, and vitiates all other organs, and death results. The lung-tissue is sometimes found as soft and rotten as tinder, and can be penetrated with the finger with greatest ease. (See case of O. Nelson.)

Capillary stagnation in lungs.

Punctiform ecchymoses in lungs of fœtus.

The stagnation of the blood in the capillaries of the lungs is sometimes striking and permanent. Rarely in the adult, but mostly in children, ecchymoses of blood are observed. In the fœtus in utero of the mother affected with cholera these ecchymoses, punctiform, and very numerous, are a constant feature.

The epithelia on the surfaces of the pleuræ are also detached and transformed into a glairy alkaline mucus. This detachment sometimes leads to friction-sound, audible by auscultation during life.

Epithelia of pleural surfaces. Friction sound during life.

The stomach glands cease in the first instance to form gastric juice, then their lumina become clogged with epithelium. This gives to the surface of the stomach a sodden thick white appearance, underneath which the vascular injection is perceived. The interglandular surface and crypts of glands denuded of epithelia then exude serous fluid, which becomes alkaline and of the same properties and appearances as rice-water in the small intestine.

Stomach glands. Contents of stomach, rice-water.

When after reaction a portion of the stomach secretes again gastric juice, those portions which are still denuded of epithelium are corroded, and with the assistance of the capillary stagnation and congestion give vent to more or less considerable hemorrhagic effusions. The blood may be vomited, or pass on in the intestine. It forms a greenish or reddish brown mass, unmistakeable by its colour.

Corrosion of stomach after reaction. Hemorrhage.

The villi shed their epithelium in extensive tracts. If of their number a great proportion remains covered, absorption, and consequent reaction, can begin early and be successful. The greater, however, the havoc amongst the villi, the more probable is a fatal termination of the case.

Villi of the intestine. The more denuded the greater the danger.

The cylindric fimbriated cells of the villi as well as the cup-shaped nucleated bodies are not only shed, but also disintegrated by the mucine fermentation ; their substance yields mucus-like matter, which decomposes quickly and leaves its residues in the rice-water.

Cells of villi dissolve and ferment.

The epithelia of all the glands of the small intestine (Brunnerian, solitary, and agminated) also participate in the general destruction, but in a much smaller degree. They may appear raised, or congested, but frequently offer no particularly abnormal appearance. It seems, however, that their condition may vary in different epidemics.

Epithelia of Brunner's, Peyer's, and Lieberkühn's glands.

After reaction has set in, and the tepid stage began, the limitary membrane of the villi produces nuclei, the first attempt at a reproduction of the epithelium. But in the first instance these nuclei or many of them perish, being developed into pus-corpuscles only, and cast off. The intestine in the reactional, tepid, or typhoid stage is indeed a vast pus-producing surface. The pus is easily seen with the naked eye as such, and in cases where admixtures disguise it uncountable corpuscles will be found in the fæces or intestinal contents by means of the magnifying glasses.

Limitary membrane of villi nucleates and produces pus.

No part of the recovering or dead choleraic body, shows the almost universal detachment of the surface-cells better and easier than the urinary passages. The secretion has completely stopped, and the canals and bladder mostly been emptied entirely of their contents just before the epithelium becomes detached in collapse. This, therefore, remains as a layer of greyish-white matter adhering to the entire surface. When the pelvis of the kidney is opened the papillæ are seen covered with the white matter, which under the microscope is seen to be cylindric epithelium partly from the papillæ themselves, partly exuded from the tubules, from which some drops can be made to exude by pressure.

Epithelia of uropöe system. Pelvis of kidneys.

On dividing the kidneys, the tubules in the pyramids from the point towards their base are seen as white streaks exuding epithelium. The tubules with flatter epithelium and the loop-shaped and contorted tubules up to the Malpighian corpuscles are less affected. Their epithelia are not shed, but have their substance filled with granular matter not otherwise seen in them. The contorted tubules in health have an epithelium which is finely granular and much darker than the

Epithelia of urinary tubules. Smaller tubules less affected. Granular matter in flatter epithelium.

Contorted tubules least changed in appearance.

light epithelium of the loop-shaped canals stretching into the pyramids. These contorted tubules of the cortex, are perhaps the least altered in appearance. The light epithelium of the loop-shaped tubules is more frequently detached, and adheres to casts formed in their interior. I must, however, remark that in the Bavarian epidemic of 1854 the contorted tubules were found much altered in their epithelium. Hence, with respect to the kidneys as well as other organs, different epidemics may observe peculiarities.

Casts more commonly detached from epithelium.

Great length of casts.

Casts contain dumb-bell-shaped bodies.

The casts found in the larger straight tubules contain more cylindric epithelium. But on the whole the casts formed within the epitheliated tubes are more commonly detached from the epithelium itself than in acute inflammatory nephritis, in which the casts are invested with, or consist of long coherent masses of the entire epithelium of a portion of a tubule. The length of the casts is often very great, sometimes from 50 to 80 times their width. They do not consist of fibrine and refuse the reactions upon that substance. They sometimes contain dumb-bell-shaped crystalline matters, which are reputed (not proved) to consist of oxalate of lime, and are very similar to artificial oxalate of lime as obtained by the addition of an oxalate to urine.

Epithelium of calyces and ureters.

The epithelium of the calyces of the kidneys is also detached like that of the ureters.

Epithelium of urinary bladder.

Cells of bladder epithelium mixed with pus.

The epithelium of the urinary bladder is always detached to a large extent even in mild cases, where the kidney lesion is very slight. In some cases which died in earliest reaction before secretion, I found the entire bladder lined with a creamy layer of yellowish matter. This was examined with the microscope, and consisted of the variously shaped one or two tailed cells of the bladder, with many pus corpuscles.

Female sexual organs.

The female sexual organs are affected similar to the uropœtic system. The virgin uterus contains a mass of mucus, consisting of softened cast-off epithelium. The vagina is covered by the same layer of epithelium and pus as has been described from the bladder.

Abdominal cavity viscosity.

The abdominal cavity has lost its easy lubricating serosity, and like the pericardial and pleural cavities contains a gum-like matter adhering as a thin layer to all surfaces. In this epithelia and triple phosphate can be found. It is sometimes so viscous that it draws out in threads between the fingers.

Cranial cavity, choroidal plexus.

No pus.

The choroidal plexuses of the brain also shed their epithelium early. They and the cerebral membranes subsequently participate in receiving a precipitate of finely granular matter, but no formation of pus-cells has been observed in them, even in cases where the tepid stage became violently febrile, and mania or oft-repeated convulsions indicated a considerable lesion of the brain. This lesion affects the nerve-tubes and ganglionic cells of the grey matter. The cylinder axis separates, the nerve marrow curdles in the algid stage.

Nerve marrow curdles.

Arrested blood changed into pigment.

Another important and common lesion is the arrest in the capillaries of the brain of masses of blood, which undergo a change and are transformed into pigment.

Urea collects in the brain and cerebro-spinal fluid.

The greatest demonstrable lesion of the brain is of a chemical nature. The amount of urea which may collect in it, and in the fluid which bathes its cavity and that of the spinal marrow, is truly astonishing. The cerebro-spinal fluid contains sometimes a higher percentage of urea than the most concentrated human urine. (See the cases of Robson, Berry, Hawkins, and Colley.)

Watery effusion in brain and arachnoid space.

The dropsical infiltration of the brain which sometimes ensues in the tepid stage causes much thickening and opacity of the arachnoid surfaces. All these lesions together are fully competent to explain the extraordinarily severe symptoms which cholera patients frequently ex-

hibit after reaction, in the last part of the algid, and particularly in the tepid or typhoid stage.

Observations concerning the female breasts.

In the quiescent state the breasts do not appear to suffer specially under the choleraic process; but cholera during lactation gives rise to severe suffering in them. The secretion of milk continues during collapse, and as the condition of the mother makes the application of the child impossible, or, at all events, because the child is not put to the breast, owing to the judgment formed by the attendants, which one should be very cautious in questioning, the milk collects in the breasts and makes them hard and heavy. Of course means are adopted to relieve the breasts, but these measures are generally unable to prevent a severe mastitis. This inflammatory process is probably similar to that which is observed in the lungs and parotid glands, and consists in a multiplication of nuclei in the acini, and basal or limitary membranes, and formation of interstitial pus. The temperature of the lactiferous breasts during collapse remains a little higher than the systemic temperature. This is owing to the process of secretion, which, like every similar process in glands, produces heat. In the breast the heat produced would probably be greater (weight for weight of glandular substance in equal times) than in any other gland, not excluding the liver. The heat is due to the process of secretion itself, as we may judge from the facts well known as regards the salivary secretion, and to the incidental chemical changes which albumen undergoes in the process. These changes may be characterized as a splitting up of the atom of albumen into two equivalent, or in all respects equal, atoms of caseine. The atomic weight of caseine is consequently only one half of the atomic weight of albumen. The formation of milk-sugar from some other material, probably hepatine or glycogenic matter, no doubt also adds to the heat.

Secretion of milk continues in collapse.

Breasts become hard.

Temperature of breasts not low.

Albumen splits up into two atoms of caseine.

The inner epithelial lining of the blood vessels participates also in the general fate of cellular surface structures; it is cast off, and may be found mixed with the blood in any of the smaller vessels. No small amount of the stagnation in capillaries, such as those of the lungs, the skin, &c., is probably due to obstruction by intravascular epithelium. When any artery is opened, and the blood washed away, its surface is found covered with a thin layer of soft gelatinous or mucus-like matter, the loosened and softened epithelium, or secondary growth of nuclei in process of swelling into pus-corpuscles, or into a mucus-like matter.

Epithelia of blood vessels.

Vascular obstruction by epithelial cells.

Inner lining of arteries softened.

Thus it is proved that the specific lesion of death of the epithelia pervades the entire body. Its universality necessitates the assumption that the whole body is under the influences (whatever they may be) of universally acting causes. As causes of such universal influence, i.e. influence upon all parts of the body, we recognize dehydration, loss of temperature, want of oxygen, want of innervation, want of nutrition. And doubtless it is amongst these influences that are to be found the causes of the universal epithelial death described in the foregoing observations.

(*h*) *Observations concerning the Parenchyma of Organs.*

The loss of water by dehydration, and by the absorption of interstitial fluid from the lymphatic spaces, makes all tissues doughy and plastic. The skin remains standing up for a long time if raised in a fold by means of two fingers.

Loss of water makes tissues doughy.

The muscles become drier, darker, and their natural contractility is diminished. They become rigid, showing slight tonic contractures, or clonic spasms. These cramps begin early or late in the algid stage, and are a very characteristic feature of cholera.

Muscles affected with cramps.

Spasms begin in the most distant parts, rise gradually towards centres.

The spasms begin almost regularly in the parts farthest removed from the centres of circulation and warmth, or in the coldest parts of the body. They then gradually ascend from the feet to the calves, thence to the thighs, from the hands to the arms, and then reach the body, abdomen, and diaphragm, and the face and chest.

Cramped muscles show deposits.

The microscopic examination of the muscles most spasmodically affected exhibits a uniform granular appearance, which is not naural to healthy muscles. This by some microscopists has been termed an infiltration, but I prefer to term the granular matter a precipitate, and believe it to be caused by the dehydration and sinking of temperature.

Urea accumulates.

At a later period urea accumulates in the muscles, and shows that the circulation through the muscular tissue is greatly impeded.

not changed. Spectrum of myochrome not changed.

The colouring matter of the muscles, myochrome, seems not to be changed to any great extent, but in a measure to be prevented from functioning. It is dark, venous, and evidently has been in want of oxygen. But its spectrum, identical with that of hemochrome, is unaltered.

Nuclei of sarcolemma multiply.

The nuclei of the sarcolemma show a tendency to multiply, particularly in the muscles with the greatest amount of precipitate. But this tendency never goes to the formation of pus. As in trichiniasis the nuclei remain as such, are later transformed into pigment, and perhaps ultimately absorbed.

Muscles may participate in gangrene of a part.

The muscles may participate in local destruction, such as the masseters in parotitis, or in gangrene of members. Thus I observed a case with gangrene of the nose and both feet. Such cases are happily rare.

Parenchyma of lungs, kidneys, and liver.

Of the parenchyma of the lungs, if any part of these organs may be so called, I have already spoken when treating of the pulmonary epithelia. The kidneys I have also treated of as if their parenchyma consisted of open canals. The liver, however, requires a special notice in this place. For here a feature is not rarely developed, which shows that its tissue, or its cells, participate actively in the diseased process. When some juice from a section is examined, a great number of nucleated cells of the size and shape of pus-cells are discovered. It is reported of some epidemics that a proportion of cases of reaction with liver-abscess was observed. Thus the origin of such abscesses becomes intelligible; they are extreme results of interstitial pus-formation, which ordinarily remains within microscopic limits.

Reported proportion of cases of liver-abcess in some epidemics.

Brain.

Diseased vessels cause extravasation.

The textural and chemical brain-lesions have yet to be studied more closely by new methods to be discovered. The grey matter is most affected in cases where mania, delirium, or violent convulsions existed. The small arterial and venous vessels are frequently diseased in such a manner as to have given way to small extravasations in and about their substance. The blood changes, and there remains diffuse or granular pigment in and about the tissues.

(C.) CHEMICAL EXAMINATION OF INTESTINAL CONTENTS AND RICE-WATER EVACUATIONS.

Rice-water.

The contents of the colon half an hour after their removal were observed to evolve gas, and to lift off the heavy glass stopper of the bottle in which they were contained. Their smell was putrid but not fæcal.

Deposit in rice-water.

The flocculent deposit which formed on standing filled one half of the bulk of the fluid. It consisted of intestinal epithelium in patches, single cells, and cells in all conditions of disintegration, and great numbers of vibriones. The fluid filtered but very slowly, and the filtrate was not clear. Its reaction was strongly alkaline. The

addition of nitric acid caused a considerable white precipitate of albumen and mucine and clouds of nitrate of ammonia hovering over the fluid. The mixture assumed a rose-pink colour, which gradually increased. The pink colour belonged to the fluid, though the precipitate was slightly stained. The fœtid smell was changed by the acid into that belonging to other putrid animal matter. On boiling the pink filtrate became nearly colourless, entirely so on the addition of more acid. In this colourless solution nitrate of mercury produced no precipitate, neither did it produce any in the unboiled pink solution. In the filtered mixture, the pink colour of which had been destroyed by nitric acid, a second slight flocculent precipitate was produced on standing. The filtrate of the rice-water was precipitated by mere boiling, strongly alkaline vapours being simultaneously evolved, which coloured blue reddened litmus paper. Nitrate of protoxyde of mercury produced a thin white flocculent precipitate of albumen and mucine. No pink reaction ensued on boiling with the nitrate of mercury, from which it may be concluded that the body upon which the pink reaction mainly depended was precipitated with the mercury compounds. The precipitation of the albumen was very complete; the precipitate assumed a yellowish tinge. When the rice-water fluid after boiling was mixed with nitric acid, vapours and the pinkiness were still produced. The body, therefore, which produced the pinkiness was not destroyed by boiling the original solution, but its reaction was more feeble than in the unboiled solution. A quantity of the rice-water was dialysed, when it was observed that the dialysate of the alkaline rice-water had an acid reaction. This was consequently neutralized by baryta water, and the fluid evaporated. From this residue several matters could be obtained; 1st, a body crystalline like leucine, and combining with nitric acid. 2nd, an oily substance, which was soluble in water, and with nitric acid gave a peculiar pink reaction. 3rd, butyric acid, combined with the added barium. 4th, inorganic salts in considerable quantity. 5th, no urea could be discovered in the rice-water.

APPENDIX.

No. 10.
On Cholera chemically investigated by Dr. Thudichum.

Reactions of rice-water.

Dialysis.

Acid reaction of dialysate.

Contents of dialysate.

The process of dialysis was difficult on account of the flocculent matter, which soon settled in the dialyser, and formed an impediment upon the diaphragm. Previous filtration was almost as difficult, and unadvisable on account of the chances of decomposition. This decomposition occurred also on the dialyser, and when it was ascertained to have materially changed the fluid the process was discontinued. 400 cub. centimetres of rice-water evolved 75·25 C.C. of gas in a tube over mercury during 24 hours. The addition of lime water to the gas produced a very slight absorption of carbonic acid. The subsequent addition of baryta water did not increase the absorption; caustic potash also failed to diminish the volume. A taper applied to the gas was immediately extinguished. Acetate of lead gave no black precipitate. Consequently the gas was nitrogen, with a small amount of carbonic acid. The gas collected during the next 24 hours was mixed with baryta water and shaken. Of 51 C.C. 24·5 were absorbed, and shown to be carbonic acid. The other 26·5 C.C. were nitrogen. The third 24 hours yielded in tube 3, 100 C.C. of gas mixtures, of which 62·5 were absorbed by baryta water and potash. We perceive, therefore, that the nitrogen evolved decreased in proportion to the carbonic acid evolved, which latter increased in proportion.

Some difficulties of dialysis.

Analysis of the gas evolved by rice-water.

Nitrogen and little carbonic acid.

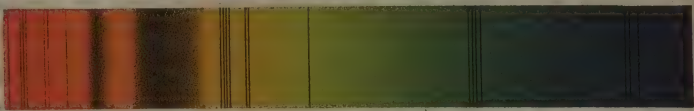
Carbonic acid increases in proportion.

	Nitrogen.	Carbonic acid.
1st 24 hours gas - - -	99°/o	1°/o
2nd „ - - -	52°/o	48°/o
3rd „ - - -	37·5°/o	62·5°/o

Hydrogen appears.

In the fourth tube collected on the fourth day some hydrogen appeared, which made the analysis of the residue, there being but one tube, impossible. On the fifth day the hydrogen continued to be evolved, but carbonic acid still increased relatively. On the fifth day the hydrogen had ceased to appear, and the gas consisted almost entirely of carbonic acid with but little nitrogen. The fluid had now made a dense deposit, and its upper layers were clear, and of a pink colour; the evolution of gas had almost entirely ceased. Some of the clear fluid placed before the spectroscope gave a spectrum which at first sight reminded much of the blood spectrum. But the spectrometer showed differences.

Spectrum of fermented cholera-stool.



Spectrum of fermented Cholera-stool.

Comparison to blood-bands.

There was a first narrow absorption-band in red, 142° 6′ – 141° 54′ = 0° 12′, and a wide one in yellow and green, 141° 42′ – 141° = 0° 42′.* The limits of the green end of the second band might, perhaps, have been 140° 54′. The green was shaded and the blue feeble. The blood-bands on the other hand (compare spectrum under urocyanine) read 141° 54 – 141° 30′ = 0° 24′, and 141° 24′ – 140° 54′ = 0° 30. So that the narrow band of the above spectrum has only half the width of the narrow blood-band, and is removed 0° 12′ more towards the red end of the spectrum. In the cholera stool-spectrum the clear interval between the two bands is 0° 12′, while in the blood spectrum it is only 0° 6′. Lastly, the broad band of the cholera-stool is 0° 42′ wide, and begins earlier in the red, while the blood band resembling it is only 0° 30′ wide; both may, perhaps, end in the same line in green. In the fresh cholera-stool no spectrum could be obtained as it was too turbid, and filtration did not make it clear. The spectrometer was next armed with the quartz-prisms and lenses, in order to see any fluorescence that might be there. Electric light was supplied by a Rühmkorff coil and battery. The fluid did not fluoresce directly, and thus differed from the cholera-stool treated with nitric acid. A band began at 142° 42′, and then there was continuous shading stretching to 140° 18′. Then there was a light strip until 139° 24′, and the rest of the spectrum was black. Hematine modified the quartz-spectrum somewhat similarly. The contracted quartz-spectrum, therefore, apparently fused the two bands, and of course displaced them on account of the irrationality of the spectrum. The particulars of this phenomenon we need not further examine. The fluid brought into the projected spectrum was not fluorescent, and thus differed from the cholera-stool treated with nitric acid, which strongly fluoresced, particularly in the pencil of the electric light, sending out a magic pink light, as if it was a self-lighting body. This fluorescent body, however, gave no absorption bands. It must be particularly pointed out that neither the pink matter giving the above bands, and which is probably a derivate from hæmochrome nor the matter giving the pink reaction with nitric acid, passed through the dialyser, into the dialysate; they remained both with the albumen and mucine on the non-crystalline side of the septum.

Fresh cholera-stool too turbid for optical test.

Colouring matters do not pass through dialyser.

Basic lead acetate produced a copious white precipitate. Nickel sulphate produced no immediate precipitate, and on boiling the fluid

* For the explanation of the scale of measurement, see D. §. Choleraic urocyaninogen.

Reactions of rice-water with metallic salts.

remained quite clear. An ammoniacal solution of silver-nitrate produced an immediate copious precipitate, which on boiling became black and reduced. An ammoniacal solution of copper sulphate produced an immediate greenish-white precipitate. Solution of cobalt nitrate produced no reaction either immediately or on boiling. Gold ter-chloride gave no reaction in the cold or on boiling; on standing gold was deposited in the metallic form. Tetra-chloride of platinum produced a very fine precipitate soluble in the fluid on boiling; alcohol caused a large precipitate in the mixture. In some specimens of rice-water this reaction was not obtained. Tetra-chloride of tin produced an immediate copious white precipitate, soluble apparently in an excess of tetra-chloride, completely soluble by heating. A very neutral solution of iron chloride caused a slight turbidity, which disappeared entirely on boiling, *while the fluid assumed a dark red-brown colour.* This reaction is known to belong to the neutral alkali-salts of several fatty acids, and is exhibited in a remarkable manner by human urine after removal of its phosphoric acid. Its occurrence in rice-water is due to the presence of acetic and butyric acid, as will be fully proved in the sequel.

Curious reaction with iron chloride.

Volatile acids obtained from ricewater-stools and intestinal contents.

A quantity of these matters in as fresh a state as could be obtained was mixed with dilute sulphuric acid and heated in a retort on a sandbath. An acid fluid was condensed, combined with potash, evaporated, and the salt obtained was redistilled with sulphuric acid. A concentrated acid was now condensed, which separated into two layers, an upper thin oily one, and a lower more bulky watery solution. The fluid smelled of acetic and butyric acid at the same time. It was treated with black oxyde of copper, but little only dissolved even on boiling. Freshly precipitated blue oxyde was added, and dissolved freely. On evaporation and subsequent cooling crystals separated. These having been isolated were boiled in water for the purpose of re-crystallizing them. But they decomposed, giving a blackish precipitate, a blue solution, and a smell of butyric acid. The mixture of liquid and crystals was therefore saturated with sulphuretted hydrogen, filtered, and the liquid neutralized by treatment with carbonate of lime; the fluid was next evaporated, filtered, again evaporated to dryness, placed in a platinum crucible, dried at 140° C to 145° C, weighed, dried until the weight was constant, treated with H_2SO_4 and ignited, and the remaining sulphate of calcium weighed. 0·5714 grammes, of calcium butyrate thus gave 0·3930 sulphate, = 0·1155 grammes of calcium or 20·21°/$_0$.

Pure butyrate of calcium requires 18·73°/$_0$, valerianate requires 16·52, propionate requires 21·27.

As the mother liquor from which the butyrate of copper had been obtained contained a considerable quantity of acetic acid, the butyrate analysed most probably contained a small quantity of acetate of lime, and this raised the per-centage of calcium by $1\frac{1}{2}$°/$_0$.

The mother liquor from which the butyrate of copper had been removed was condensed, and the acetate of copper which crystallized was isolated. It was then dissolved, treated with potash, heated, filtered, and the oxyde weighed. 0·285 grammes of dry salt gave 0·11 grammes of oxyde, corresponding to 0·0878 grammes of copper, or 30·87°/$_0$. Pure acetate of copper requires 31·8°/$_0$, butyrate 18·73°/$_0$.

The volatile acids obtained from rice-water were therefore butyric and acetic, the latter apparently prevailing in quantity. They were combined with ammonia in the original fluid, and could not have been formed by the sulphuric acid acting upon albuminous substances. For butyric acid was also obtained from the dialysate of rice-water and the experiments on the decomposition of albuminous substances by sulphuric acid,

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without the aid of oxydizing agents, teach us, that although a very little volatile acid is evolved, yet no such quantities of butyric and acetic acid can be obtained as are readily evolved by rice-water.

Rice-water, therefore, contains the following ingredients :—Vibriones, cells from the surface of the intestine, granular debris of cells, mucine, modified hemochrome, albumen, albuminous body giving rose-pink reaction, butyric acid, acetic acid, ammonia, leucine, inorganic salts. It is in an active state of decomposition and evolves gas, which at first is composed almost entirely of nitrogen ; soon, however, carbonic acid prevails, and ultimately nothing but carbonic acid is evolved. At one period some hydrogen is developed.

We cannot discover any specificity in the above ingredients, but many of them are analogous to the products of ordinary processes of putrefaction. If it is admitted that the cholera-evacuations acquire infective powers only after a period of fermentation, it is also easy to understand that the specific infecting power may belong to albumen or mucine at a particular stage of disintegration or chemical cleavage. The next knowledge which it is necessary to acquire is evidently this, namely, the exact period at which rice-water acquires infective properties, and its chemical composition at that period. I have made a few experiments in that direction. Their results have clearly exhibited the increase in the difficulty which the human intellect experiences with the nearer approach to the problem of the definition of disease.

(D.) Short Account of the general Features of Urine of Cholera Reaction, with special Supplement on Choleraic Urocyaninogen.

First urine, general features.

As the complete suppression of the urinary secretion in collapse, lasting for hours or days, is one of the most striking and peculiar features of cholera, so its re-appearance is amongst the earliest and most auspicious signs of beginning recovery. The first secretion mostly contains the evidence of the mechanical obstruction of the minute channels of the kidneys, and of the general death of the epithelia of the urinary passages. It also contains the sign of continued resistance to the blood current through the kidneys in the form of transuded albumen of the blood. And in many cases it carries small quantities of peculiar abnormal ingredients, which may perhaps be products or remnants of processes engendered by the choleraic process in the blood.

Out of upwards of 30 cases of cholera, in which an opportunity for examining the urine was afforded, only about 18 yielded first or early urine of reaction with characteristic properties of that stage. In several of these 18 cases the only specimen obtained was taken from the body after death.

Small quantity of first urine of reaction.

The first urine passed by persons recovering from collapse was mostly small in quantity, as little as six cubic centimetres being observed. After the first excretion, which afforded one limit of the measure of the secretory activity compared to time, several hours frequently elapsed before a second excretion affording the other limit took place. This yielded generally a larger amount of fluid than the first, but its measure remained greatly below the normal standard. When the urine excreted during the first 24 hours after the re-establishment of secretion was united and measured, it was sometimes found as low as 70 cubic centimetres, being only one-tenth of what would have been excreted in acute febrile diseases, and only one-twentieth of the normal standard of health.

Urea much diminished.

To this diminution of the urinary water corresponded a great diminution in the amount of the principal ingredient, urea. In one case the total quantity of urea excreted during the first 24 hours after the secretion had begun amounted to only 0·9 grammes, being only about one-thirtieth part of the secretion which a healthy individual of the same weight would have produced during the same time. The urine was dilute, the urea being to water in the relation of 1·4 to 98·6. In health the urea is in round numbers 2°/$_\circ$ of the urinary water, and in febrile conditions it rises to 3 and 4°/$_\circ$. There is consequently no condition of health or of febrile disease, and as far as our present knowledge goes, no other condition of body whatsoever in which chemical change as expressed by the excretion of urea may be so much diminished as in cholera.

Uric acid.

The first urine mostly contained appreciable quantities of uric acid, but not more than would correspond to a feeble proportion in normal urine. In some cases the acid was spontaneously deposited in the crystalline state. Oxalic acid, which may be termed an accidental ingredient of normal urine, and which obtains great pathological importance in cases where its lime salt manifests a disposition to crystallize and form concretions in the body, was mostly present in first cholera-urine to the amount of several centigrammes. Of the inorganic salts chlorides were either absent or present in traces, phosphates and sulphates much diminished. The colour of first urine was mostly pale yellow, sometimes, however, saturated yellow, rarely dark. It was turbid by suspended formed ingredients, and appeared of a darker colour when these matters were removed by filtration. The colour was due to ordinary urochrome, and perhaps in part to the admixture of one or two different bodies which with acids yield blue and red products, and which have therefore been designated as urocyaninogen and urorubinogen. Albumen in small quantities was mostly present, rarely absent. Of formed ingredients there were the casts of the urinary tubules, and the different kinds of epithelia of the urinary passages, which have already been described under the anatomical section treating specially of the epithelia. Pus-cells were observed in many cases. Sometimes there were sporules single and double, and more or less developed fungi. These signs of decomposition, together with abundance of vibriones, were the more developed the more the neutral or acid reaction had passed into the alkaline, and the more the presence of ammonia carbonate was indicated by the deposition of crystals of triple-phosphate. Lime-phosphate in needles and dumb-bells was also observed in cases where the decomposition had gone farther, mixed with spinous globules of soda urate. In such cases the pus-cells formed the usual ropy masses of adhesive mucus.

Oxalic acid. Inorganic salts. Colour. Urochrome, cyanino and rubino genetic matter. Casts of tubules. Epithelia, pus. Sporules and fungi, vibriones. Triple-phosphate. Lime-phosphate. Ropy masses.

Urine in later stages of cholera.

In the torpid, tepid, and febrile stages the urine assumed properties and was excreted in quantities corresponding on the whole to the thermic conditions of the body, and the rapidity of pulse and respiration, in such a manner as on general pathological grounds from a knowledge of these conditions might have been predicted.

§ *Choleraic Urocyaninogen.*

The earliest urine voided by choleraic patients entering upon the stage of reaction, not rarely contains a peculiar principle, which has the property of generating a blue colouring matter, when the urine is cautiously boiled with a sufficient, but not excessive quantity of nitric acid.

APPENDIX.

No. 10.
On Cholera chemically investigated by Dr. Thudichum.

Discovery of choleraic urocyanine.

This production of a blue matter from the urine of cholera patients was first observed by Gubler (Gaz. Méd. de Paris, Dec. 16, 1854). The usual colour of the urine which gave him the test was very pale yellow. He found the blue more evident when impure nitric acid, containing nitrous acid, was used. He never found any green tinge, but the blue persisted for some time and then faded. He believed that there was some analogy between this matter and the colouring matter of bile.

These observations were a year later confirmed by H. Osborn, (Medical Times and Gazette, March, 1855, 307,) and Lauder Lindsay (Ibid. May 1855, 460.) Osborne observed that the urine of a cholera patient recovering from collapse had a dark colour and turbid appearance, was acid, and of specific gravity 1020. The addition of a little pure nitric acid changed the colour to reddish, then deep violet, and a blue powder was ultimately deposited. When nitric acid containing nitrous was used, effervescence was produced, and a brown precipitate subsided, in which the microscope discovered some blue specks; the supernatant fluid remained of a straw-colour instead of a deep violet. Hydrochloric acid acted exactly like nitric acid in producing the blue precipitate and violet coloration. The blue matter appeared soluble in alcohol. On adding a solution of potash to the blue precipitate, the solution gave, with a persalt of iron, a pale blue; and with a protosalt of that metal a greenish precipitate, insoluble in hydrochloric acid. Sulphate of copper threw down a reddish brown precipitate from this solution by potash. The urine of the patient gave a less amount of blue precipitate as convalescence became established.

Lindsay had under his care a man, aged 52, who was in collapse, with cramps and cyanosis, although he was returned as a case of cholerine only. The patient passed some urine with his stool on evening of second day, but only the second urine, which was passed on the morning of the third day, could be collected. Its specific gravity was 1020; it was acid, slightly albuminous, and contained casts of the tubules, bladder-epithelium, dumb-bells, and granular and globular urate. Nitric acid caused a dark brownish colour, which immediately became converted into green, and slowly repassed into brown. The colouring matter attached itself to particular substances, epithelial scales, mucous corpuscles, and extraneous vegetable fibres. In this case the blue or green (the author is not quite certain about the colour) colouring matter was developed subsequently to the addition of HNO^3, preceded by heat. The first urine collected only gave the reaction. HNO_3, added cold, produced a brownish red colour and a copious brown flocculent precipitate, which, on standing in a test tube, became granular, dark, and of an earthy brown colour. The sides of the tube were sparingly coated with a greenish blue granular deposit, which under the microscope appeared to consist wholly of blue granular matter, entangled in mucous fibrillæ. HCl produced a similar brown colour and deposit; liquor potassæ caused the development of a green colour, and the formation of a flocculent precipitate; watery ammonia also caused a sediment, but produced no marked change of colour. On the fourth day the urine gave no pigment reaction.

Subsequently Lindsay, on evaporating a mixture of the first urines of four collapse cases entering upon reaction, observed that as the fluid reached the boiling point a copious scum of a beautiful Prussian blue colour formed on the surface. Microscopically it seemed to consist wholly of urates having a blue tinge.

In a subsequent note, published in the "Medical Times and Gazette," of August 1855, p. 191, Osborn described the results of an examination

of the urine of a surgeon, who attended many cases of cholera. It gave a small precipitation of the blue matter. The copper test was more feeble. This case is unimportant, except perhaps as showing that a blue matter may occur in healthy human urine.

Alleged hepatic cyaninogen.

An observation was made about the same time by Claude Bernard, which seemed to throw some light upon the possible origin of the choleraic urocyaninogen. In a decoction of liver, filtered and decolorised by charcoal, nitric acid produced the same reaction as in the cholera urine. The paleness of cholera urine is therefore, concluded Bernard, no argument against the supposition that the blue matter is derived from colouring matter of bile. This assumes, however, that the pale matter in the liver-decoction is colouring matter of bile. More correctly, it might be assumed that the pale matter is a substance preceding the formation of biliary colouring matter in the downwards metamorphosis of albuminous bodies.*

The occurrence of a blue matter in the urine of healthy persons, or in that of persons suffering from certain diseases, had before frequently attracted attention. By some authors the pigment received particular names, such as cyanurine (Braconnot), and uroglaucine (Heller). But Prout had long ago related an observation referring to a blue matter deposited from urine, which matter he had identified with indigo. Heller subsequently, and more emphatically his assistant and successor, Kletzinsky, declared his uroglaucine to be identical with indigo. Hassall gave a larger scope to this enquiry, by a publication in which he asserted the frequent occurrence of indigo in putrefying healthy urine. In his report to the General Board of Health on the chemical examination of the urine of cholera patients of the epidemic of 1854, he gave an account of numerous instances in which the urine of cholera patients developed indigo on standing. Thus, out of 29 samples of the urine of one patient, as many as 18 are said to have developed indigo. The blue colour of small particles, sometimes only visible with the aid of the microscope, was apparently the only criterion upon which they were assumed to be indigo.

The reaction with nitric acid, which is exhibited by the earliest urine of cholera patients, was also observed by Buhl (Bavarian Rep. 521). He only obtained violet or purple, but no actually blue reactions, probably because he omitted to boil the mixture. In some cases I observed reactions similar to those described by Buhl, and on subsequent boiling, and sometimes the addition of more acid, the deep blue matter became deposited. Buhl left it undecided whether the matter yielding the reaction was a modified colouring matter of bile, or one of Heller's particular urinary colouring matters. He agreed with cotemporaneous observers in this, that the cyaninogenetic matter was much diminished in the second, and had entirely disappeared from third and later urines.

Application of the Spectroscope and Spectrometer to the diagnosis of choleraic Urocyanine.

During the epidemic of 1866, a number of specimens of first urine of cholera patients came under observation, which yielded the purple and blue reaction. The blue, violet, and red matters obtained seemed to offer an opportunity for the employment of the spectroscope, and were accordingly scrutinized.

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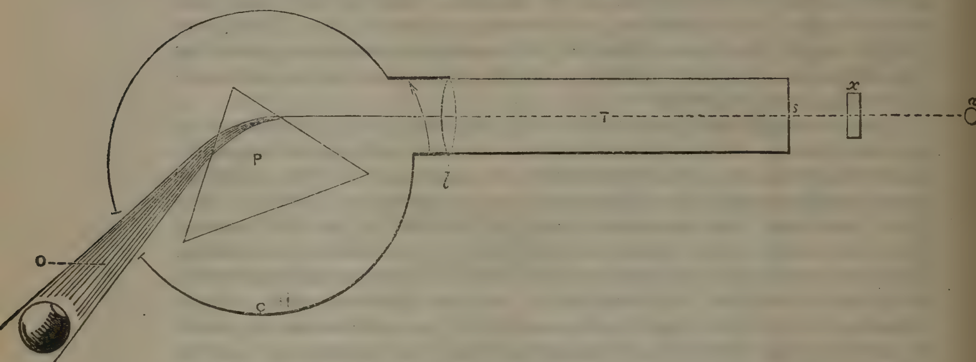
* I repeated this experiment of Bernard upon human, sheep's, and dog's livers. None of the decolorised decoctions was found to give any coloration with nitric acid, with or without boiling.

Instruments and methods employed.

For the observation of the ordinary non-magnified spectrum, I employed a number of spectroscopes of my own construction. These consisted each of a large sulphide of carbon prism, made under my immediate superintendence, with great accuracy, by Mr. Orchard, of Kensington. The prism P was placed in a drum-shaped dark chamber C, to which a tube T, with a fixed slit *s*, and condensing lens *l*, was adjusted at the proper angle. The spectrum was seen entire through an oblong opening O in the side of the drum. The light, a paraffin



lamp, was placed at *a*, and the fluid to be examined at *x*. The light was then made to pass through the problematical solution, its rays were purified at the slit, made parallel at the lens, and broken prismatically in the sulphide of carbon wedge. The eye at the other side received the entire spectrum as modified by the interposed fluid, and was easily able to define the great features of these modifications by comparison with the normal spectrum when the interposed fluid was withdrawn.

The advantages of such a simple spectroscope were repeatedly illustrated in the course of my research by the instantaneous observation of peculiarities, which could not so easily be seen in the magnifying spectroscope, and might have escaped observation by means of this latter instrument.

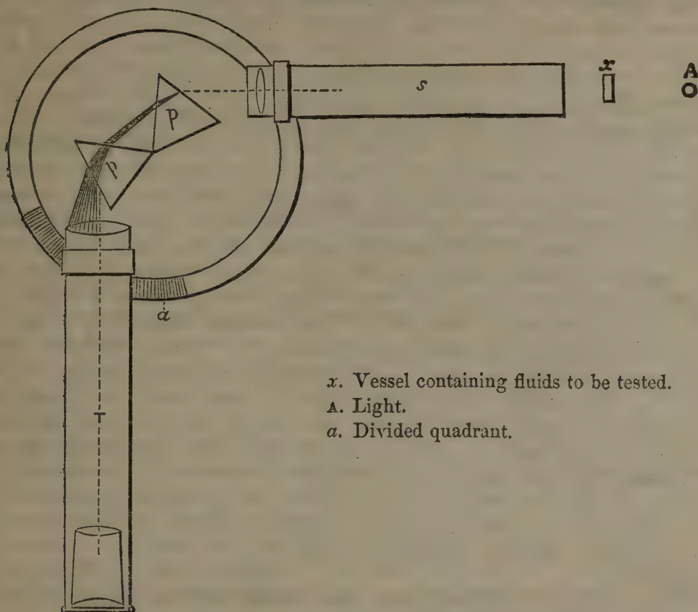
I also employed a spectroscope constructed upon the original plan of Bunsen. With this instrument a telescope magnifying about four times was employed. The prism was one of my sulphide of carbon instruments, and turned on, and with a disk in a dark chamber, by means of a lever clamped underneath the dark chamber upon the axis of the disk. The slit of this instrument was moveable, and a glass prism could be adjusted to it, so that the normal and altered spectrum could be made to appear simultaneously the one above the other.

But although valuable observations and general comparisons could be made by these instruments, and although their spectra were of great purity and precision, yet they admitted of no accurate measurements, and the changes of temperature unavoidable in a chemical laboratory, and very great in so frail a wooden structure as mine, caused undesirable currents in the sulphide of carbon prisms.

I therefore employed by the side of these instruments a spectrometer by Mr. Ladd, of Beak Street, which was provided with two flint-glass prisms *pp*, and beside the slit-tube S, with a telescope T. While in Bunsen's original spectroscope the entire spectrum is brought into view by turning the prism, in this spectrometer the telescope is made to

move upon an arm, which centres somewhere in the middle of the disk which carries the prisms.

This arrangement gave a very good spectrum. By means of the easy



x. Vessel containing fluids to be tested.
A. Light.
a. Divided quadrant.

motion of the telescope the platinum wire on the diaphragm of the eye piece could be brought into close adjustment to the margin of any spectral lines or bands. The arm carrying the telescope could then be clamped, and the final adjustment be made by means of a fine-threaded screw. The position of the wire could then be learned by reading the position of the index on the divided quadrant of the disk. The only inconvenience attaching to this instrument was that the observer had to rise after every observation, in order to read off the scale. This should be avoided in the construction of any similar apparatus, by engraving the scale on a broad ring, and making it readable through a short system of glasses, having its eye piece just underneath that of the telescope.

To those well acquainted with the use of the spectroscope and its difficulties, some of the above details and the description of precautions observed to follow hereafter may perhaps appear unnecessary. But such is perhaps hardly the case with most medical readers, to whom, if not the knowledge, yet the use of the spectroscope is as yet a novelty. These, then, will perhaps be better able to judge of the value of the following results by knowing something of the manner in which they have been obtained.

The spectrometer, with diffuse sunlight or the light of a lamp, burning gas, paraffin, oil, or tallow, gives a good large spectrum. This spectrum I at first endeavoured to measure by determining the D line by means of sodium, and then making this a zero point by measuring from it in two directions. But finding the description of the direction inconvenient, I determined the principal Fraunhofer lines of my spectrum by means of a heliostat. Every change produced in the spectrum by substances to be analysed could thus be referred to the only fixed points in the spectrum, the lines of Wollaston and Fraunhofer.

But in this process the following difficulty arises. The lines of the entire spectrum cannot be read with the same adjustment of the eye-piece. This difficulty arises with all magnifying spectroscopes, and spectrologists have adopted the device of avoiding it, by seeing their spectra with what is termed "medium clearness." A certain portion of the clearness of one part of the spectrum is sacrificed, in order to be able to see with the same adjustment another part of the spectrum, which, if the first were viewed absolutely well defined, would not be defined at all. But with this medium clearness, which serves me very well for the spectra of hot metallic gases, and for ordinary observation of absorption phenomena, my eyes cannot fix the solar lines of the entire spectrum, so as to read them off repeatedly with the same accuracy. When proceeding from the red to the violet end of the solar spectrum, I arrive at E and b, or the middle and end of green, at a region where it becomes necessary to shorten the focus by pushing in the eye-piece a little, in order to obtain a fair congruity of the eye-piece wire and the lines of the blue and violet part. This produces what I may be allowed to call an "artificial or telescopic irrationality" of the spectrum, which destroys a little the accuracy of the relations of both its wings to each other in the metric conception. But if both wings are considered separately, all measurements lying between A and b on the one hand, and between b and the violet end on the other, are, with the best adjustment obtainable, accurate amongst themselves. For the rest, this source of relative error happily affects the principal points of the following observations very little, inasmuch as the phenomena to be discussed are mainly situated in the first or red end part of the spectrum.

We are thus enabled to attribute their actual and no exaggerated value to the following determinations:

When the platinum-wire of the eye-piece covered a line X, seen with the best adjustment obtainable for one-half of the spectrum, the point of the arrow on the indicator of nonius stood upon Y degrees Z minutes.

Single minutes could no longer be read. Two and three could be estimated. The constantly changing intensity of the brightest sun-light produced slight variation in the readings, so did the inaccuracies of the heliostat. But ultimately the following measurements were assumed as determined:

Red end of spectrum 143°. (Difficult and changeable.)
A 142° 54′
a 142° 42′
B 142° 30′
C 142° 18′
D 141° 42′
E 140° 48′
b 140° 36′ Focus shortened; eye-piece pushed in.
F 140°
G 138° 24′
H 136° 54′
H′ 136° 48′
Violet end 136° 18′ (Most difficult to determine.)

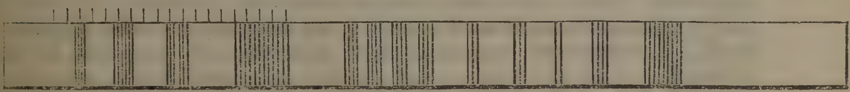
By repeated observation, it was found that the ends of the spectrum could not be absolutely determined within a fluctuation of 0° 6′. But the error never had wider limits. The same was ascertained to be the chance of error in the reading of the terminals of feeble absorption bands. My readings might differ by 0° 6′ from each other, or the

readings of my assistants might differ from my own by 0° 6′, but rarely or never more. But when the bands were dark and well-defined, such as blood-bands, or the band of concentrated hematine solution, any number of readings made successively by myself or my assistants would always give the same results.

Methods of rendering Spectra on Plates.

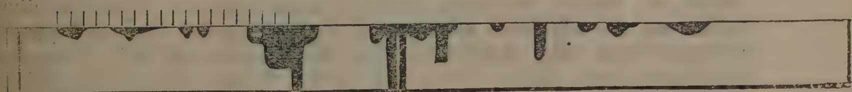
I was desirous of accurately representing the spectra observed, and of having a ready means of comparing them at a glance to other known spectra. For this purpose I instructed a lithographer to prepare me sheets with the spectral colours imprinted in their usual succession and proportion. Every section at right angles to the colour bands thus represented a spectrum of the size and appearance of that seen in the spectroscope or spectrometer. On these I entered the solar lines in the closest possible approximation to the places in the colours which they naturally occupy. When the solar lines were not entered, the slips were, with the ends of the spectrum properly adjusted, fixed upon a rack of parallel lines representing the scale of the spectrometer. Any line observed could thus be immediately drawn in its proper place in the spectrum on the paper. But although the places of lines and limits of absorption bands could thus be fixed, it was found difficult to express the amount of shading belonging to each band. The estimate of the eye had, therefore, to be relied upon in this particular. Professor Bunsen, in his Researches on Erbium and Didymium (Ann. Chem., Jan. 1866, p. 1), and the absorption bands of their compounds, has experienced the same difficulty, and adopted a way out of it which is ingenious and more ready-handed than the attempt at direct representation. Classifying the intensity of absorption bands by assuming several degrees, he represents each absorption band by a conical black mark, having for its base the entire width of the band at the margin of the spectrum, and projecting to the eighth, fourth, half of the width of the spectral band, or passing right through it so as to touch the opposite margin. The longest cone would therefore represent the blackest band; its base would represent exactly the entire width of the band. Thus, a spectrum of a didymium compound, having the following appearance,

FIG. 5. Absorption spectrum of didymium sulphate crystal.*



would be represented by a figure here drawn. This method has moreover the advantage that it can be employed with the ordinary letter-

FIG. 6. Spectrum of didymium sulphate crystal, as represented by Bunsen.



press in the text of books, where such shading off, as is yet possible but difficult in lithographic representations, would be impossible.

* The figures 5 and 6 represent parts of spectra only, reaching from A half a to F six-seventh G. They are therefore nearly double the width of the spectra employed in the succeeding portion of this section.

APPENDIX.
No. 10.
On Cholera, chemically investigated by Dr. Thudichum.

For quick registration of observations this mode of representation is excellent. It is no less suitable for showing the difference in the clearness of various bands of the same spectrum. For simple absorption bands like those we have to discuss hereafter, the direct representation of shaded bands on coloured spectra, is perhaps more instructive to the uninitiated reader. But the method of Bunsen is advantageously employed for registering the maxima and minima of darkness and clearness of bands as obtained by either diluting or concentrating the fluids examined, thickening or thinning the layer of fluid examined, or increasing or diminishing the light.

The Spectrum of Urocyanine from Cholera-urine.

The first or earliest obtained urine of several cholera patients yielded on treatment with appropriate quantities of nitric acid and boiling a considerable precipitate, which was mostly more or less coloured. This consisted of albumen, to which a colouring matter remained attached, either in particles, or uniformly like a dye. The precipitate in the case of Maria Willis, e.g. (Aug. 10) was of a dark-brownish purple colour. Filtered and washed, the dark matter dissolved in boiling alcohol with a purple blue colour. In the spectroscope this solution exhibited an absorption band in red to yellow. Limits red end = 142° 30′; limits green end 141° 54′; violet end cut off entirely at the beginning of blue; *i.e.* at the *b* line or 143° 36′.

FIG. 7. Spectrum of urocyanine in alcohol.

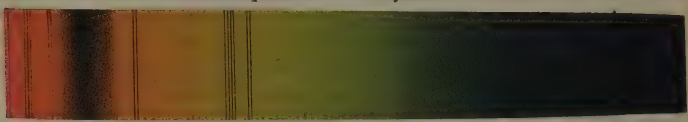
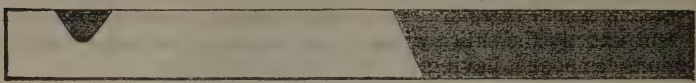


FIG. 8. Schematic representation of urocyanine spectrum.



The absorption band had therefore a breadth of 0° 36′ of the spectrometer. The solution was one centimeter in thickness. Its colour and spectrum remained unchanged by the addition of some sulphuric acid. The intensity was about half saturation as expressed in the diagram. After the solution had stood at rest for 24 hours, some blue matter had been deposited upon the sides of the glass, and the particular spectrum was replaced by an ordinary one. It was thus shown that the urocyanine is soluble in alcohol only in the nascent state, and soon becomes insoluble. Its quantity was so small, that beyond a test with nitric acid, which showed that it was destroyed, leaving some yellow colour, no further reactions could be made with it. Several other specimens of early urine of reaction yielded similar blue and purple matters, which also admitted of the identification of their absorption phenomena with those of the case of M. Willis. (O. Nelson, slight purple; C. Robson, Jane Turnbull, C. Jackson, very slight; and others.)

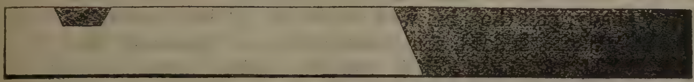
The Spectrum of Urorubine from Cholera-urine.

The urine of a patient named Smith, August 18, voided 24 hours after beginning of reaction, and which, though of usual colour, contained some blood corpuscles, visible microscopically, yielded a moderate

precipitate of albumen, but a considerable *pink* colouration with nitric acid, both hot and cold. This became yellowish brown on addition of excess of HNO_3, but in other respects behaved like the urocyanine. It had almost the same spectrum; for dissolved in alcohol it showed a faint absorption band from red to orange, measuring $142° 24' - 141° 54' = 0° 30'$.

FIG. 9. Spectrum of red colouring matter from cholera-urine.

FIG. 10. Schematic representation of the foregoing spectrum.



This absorption band, then, was narrower apparently by 0° 6′ on the red side of the spectrum, while towards yellow it exactly coincided with the terminal of the urocyanine band represented in fig. 9. The violet end was entirely cut off from the beginning of blue. We shall see subsequently that an absorption band of a similar kind, that of hematine, when, by the changes of concentration, thickness of layer, or intensity of light, it is brought through all the stages of intensity down to the intensity of the band, fig. 9. loses also about 0° 6′; this loss occurs earlier on the red end on account of the greater intensity of the red light; but on continued dilution the loss is also observed on the yellow side, just before the total disappearance of the band. It follows from this consideration that the feeble spectral band, fig. 9, of the red matter from cholera urine does not differ essentially from the band, fig. 7, obtained from the blue matter, and that, in short, as both the spectra terminate with the beginning of blue, both are identical.

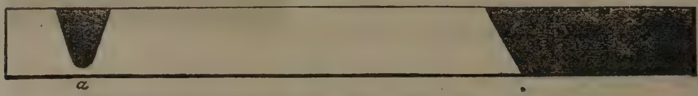
In many reactions on early cholera urine, either blue or violet or red precipitates were obtained, or at least the various coloured precipitates could be extracted from the albumen by alcohol with these ultimate colours. In no case was the urine itself, or filtrate, observed to yield any spectrum with bands or specific absorptions; but several specimens of early urine, amongst them some which there was every reason to believe were first urines, after reaction yielded either no coloration at all with nitric acid, or only such a feeble one that no alcoholic solutions for spectral observation could be produced.

Comparison of Urocyanine Spectrum with the Spectrum of Indigo.

A blue matter, which had been frequently observed from human urine not choleraic by various authors, had so often been declared to be indigo, that the choleraic urocyanine could easily be supposed to come under the same category. It was therefore natural to compare the spectra of indigo and some of its compounds with those of the purple and red matters above described. Indigo was heated on a bright sheet of platinum, and the crystalline sublimate which formed on the top of the powder was extracted with boiling alcohol. This yielded a somewhat blue solution, the quantity of matter dissolved being very small.

FIG. 11. Spectrum of indigo in alcohol.

FIG. 12. Schematic representation of spectrum, fig. 11.



This exhibited an absorption band in red to orange, measuring 142° 24′—141° 48′=0° 36′. The yellow was overshadowed, the green slightly shady, and the blue was as lively and long as in the ordinary light spectrum. Indeed, sometimes the green appeared blue, the blue brighter, and prolonged a little towards violet; but at the end of blue perfect darkness succeeded.

Sulphindigotic acid of commerce was next subjected to special examination, and yielded almost exactly the same spectrum as indigo in alcohol. The solution, to give any spectrum, could only be slightly blue. It then showed a band from red to orange, 142° 24′—141° 48′= 0° 36′. Green and blue were a little shaded.

The spectrum of indigo and sulphindigotic acid, therefore, resembled the spectrum of urocyanine by the existence in red of an absorption band having 0° 36′ in breadth; but while the situation of the band in urocyanine is from 142° 30′ to 141° 54′, that in indigo is from 142° 24° to 141° 48′, or the urocyanine band lies 0° 6′ more towards the red end of the spectrum than the indigo band; consequently those bands, although very similar to each other by breadth and situation, are *not identical* in optical value. The rest of the spectra of urocyanine and indigo differ still more, and according to my present belief, still more specifically than by the differences between the bands in red. In the indigo spectrum the blue is at all events unaltered, and a blue cast is thrown over yellow and green. But the spectrum of urocyanine shows no blue at all; at the end of green the spectrum is cut off, no manipulation, such as those above related can make it appear, no concentration of the indigo solution that allows the band to appear extinguishes the blue part of its spectrum. The proof that these bodies, if both are in a pure state before us, are not chemically identical, however related, is complete.

Comparison of Urocyanine Spectrum with Spectrum of blue Pigment from Cholephaeine, Cholocyanine.

As the colouring matter of bile has long been known to produce with nitric acid a blue colour among others, and as the reaction of cholera urine had in the Bavarian report been likened to this reaction of bile pigment, I instituted a comparison as follows:—An ammoniacal solution of cholephaeine (C_9 H_9 N O_2) was treated with concentrated nitric acid until a blue precipitate was formed. This was quickly isolated by filtration, and after washing with water, dissolved in alcohol. It yielded a spectrum resembling that of indigo and also of urocyanine. It showed a band which at medium intensity measured 142° 6′—141° 48′=0° 18′. The red was shortened; the green was somewhat obscured; the first half

FIG. 13. Spectrum of cholocyanine.

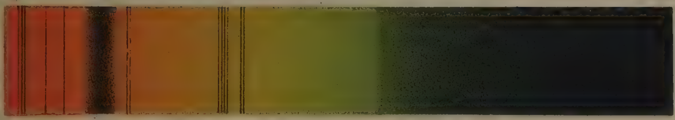
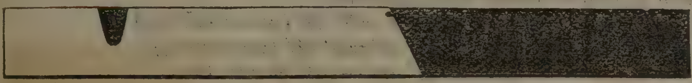


FIG. 14. Schematic representation of spectrum, fig. 13.



of the blue was clear, but the second half and the rest of the spectrum entirely obscured. Consequently the spectrum resembles indigo by its band and its blue part, but differs from indigo by the smallness of its band, measuring only 0° 18′, while that of indigo measures 0° 30′, and by being obscured from the half of blue to the violet end, while indigo shows the whole of blue. From urocyanine the spectrum of cholocyanine differs as from indigo by the band, but it approaches more to urocyanine than indigo by the partial obscuration of the blue, which in urocyanine is entirely absent.

This cholocyanine could also be obtained by the action of fuming sulphuric acid, and subsequently water upon cholephaeine, together with various other green products, insoluble in water. The very dilute watery acid solution showed spectrum; band from 142° 12′ to 141° 48′, very feeble; yellow obscured; red dimmed; green lively; blue only one half its ordinary length; rest obscured. This then is the same spectrum almost as cholocyanine by nitric acid, differing only in this non-essential particular, that the terminal of the band on the red side is 0° 6′ more advanced towards red than that of cholocyanine. A similar difference we have disregarded in the case of the red matter from cholera urine and of urocyanine. But attention should nevertheless remain directed upon the fact that it is the line nearest to yellow which remains the same (141° 48′) in both preparations of cholocyanine, while in the one last discussed the breadth of the band increases towards the red end of the spectrum.

In this place may be noticed an observation which may perhaps have some bearing upon the explanation of the transition of the ordinary blood spectrum into that of hematine. This is the more important to be noticed, as the spectrum of hematine possesses much similarity with the spectrum of urocyanine from cholera urine, and with urorubine from the same; the alcoholic solution of urorubine cannot by the eye be distinguished from one of hematine.

Cholephaeine was treated with 15 times its weight of sulphuric acid hydrate. After standing six hours it had assumed a reddish green black colour. Diluted with sulphuric acid it was almost impenetrable to light; but red, then a dark band, and then some light could be seen; the rest was obscurity. More diluted there appeared red, then the band 142° 18′—141° 36′=0° 42′. This band, in the concentrated acid solution, is broader in both directions than the band of cholocyanine in dilute watery solution prepared by fuming sulphuric acid. The line 141° 36′ was difficult to read, and therefore somewhat doubtful. A second reading of dilute solution gave 142° 6′—141° 36′. A third reading of the spectrum of the concentrated solution between two glass-plates, so that a very thin layer only had to be traversed by the light gave 142° 18′—141° 24′, blue and violet being cut off. Now this concentrated solution, treated with much water, deposited a pre-

cipitate of which a part was soluble in alcohol. This solution is red, and shows two remarkable bands of absorption, resembling much the absorption bands of blood. The first narrow band on the red side of the spectrum measured

142° 18′—141° 54=0° 24′ (own reading,)
142° 12′—142° =0° 12′ (assistants,)
Mean 142° 15′—141° 57′=0° 18′.

The second or broad band measured

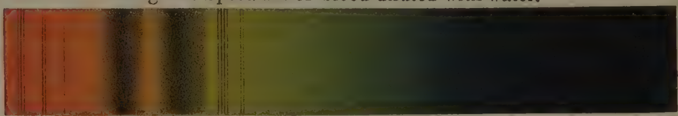
141° 48′—141° 6′=0° 42′ (own reading,)
141° 48′—141° 12′=0° 36′ (assistants,)
Mean 141° 48′—141° 9′=0° 39.

The green ended in faintest bluish black, and the spectrum altogether at 140° 54′.

Fig. 15. Spectrum of alcoholic solution of product by sulphuric acid from cholephaeine.

How closely this simulates the spectrum of blood is evident from a comparison of the views and readings, which, however, at once give us all the essential differences.

Fig. 16. Spectrum of blood diluted with water.

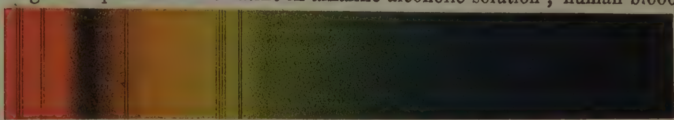


The first narrow red side band measures invariably 141° 54′—141° 30′ =0° 24′, and the second 141° 24′—140° 54′=0° 30′. There is green, some feeble blue, and the spectrum is then cut off at 138° 54′.

Comparison of Spectrum of Choleraic Urocyanine with Spectrum of Hematine.

Human blood, which yielded the spectrum just described, was treated with a concentrated solution of carbonate of potash. The solution of carbonate consisted of one part of potash and two parts of water, and of this solution six parts were mixed with one part of blood. The reddish-brown precipitate which ensued was filtered off, pressed, and dried, and treated with alcohol in the cold. A splendid red solution was obtained, which showed a spectrum with the following peculiarities :—Red very vivid ; absorption band from orange to near green, measuring 142° 21′ — 141° 36′ = 0° 48′, the terminal towards green being with difficulty ascertained, on account of the green being very much shaded. When the solution was more diluted with alcohol, the band measured 142° 18′ — 141° 42′ = 0° 36′. Another reading, 142° 18′ — 141° 48′ = 0° 30′. The green end still difficult to see. Green greatly shaded from 141°. Spectrum entirely cut off by darkness at the b line, 140° 36′.

Fig. 17. Spectrum of hematine in alkaline alcoholic solution ; human blood.



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On Cholera chemically investigated by Dr. Thudichum.

Fig. 18. Diagram of spectrum of hematine.

Neither efforts nor materials were spared to obtain a chemically pure specimen of crystallised hematine, and to determine the spectrum finally in such crystallised material. But the success, now nearly certain, and to be described elsewhere, did not come in time for the present research. The spectrum of hematine has, however, proved the same under so many varied circumstances, that I have no doubt that the figures and drawings above given are materially correct.

The hematine spectrum, then, resembles the spectrum of choleraic urocyanine by the presence of an absorption band in red and orange 0° 36′ broad, by much shading in the green, and by being cut off entirely at the b line, or 140° 36′. But the absorption band of urocyanine is placed by 0° 12′ nearer to the red end of the spectrum.

The spectrum of hematine also resembles the spectrum of the red colouring matter or urorubine obtained from choleraic urine by its absorption band, and its ending in the green, but this band is perhaps 0° 6′ narrower in urorubine, and lies 0° 6′ more towards the red end than the band in hematine.

The spectrum of indigo solutions resembles those of hematine by the band; but this band in the indigo spectrum lies 0° 6′ more towards the red end of the spectrum than in hematine solution.

There is yet another derivate of the colouring matter of the blood, the spectrum of which presents analogies to the spectra examined above, namely, hemine.

Comparison of the Spectrum of Urocyanine and Urorubine from Cholera Urine, with the Spectrum of Hemine.

Blood, putrid or fresh, when mixed with much water and some acetic acid, yields a precipitate and a coloured solution. If this is quickly placed before the spectroscope, the blood-bands are yet seen, but feebly; they soon grow paler, and disappear. At the same time a shade becomes perceptible in red, which forms into a band. In a concentrated solution this band measures 142° 42′ — 142° 12′ = 0° 30′. Green is much shaded, and cut off at the beginning of blue, *i.e.*, nearly the b line. A very concentrated red solution gave a very dark band measuring 142° 36′ — 142° 6′ = 0° 30′.

FIG. 19. Spectrum of hemine in acetic acid and water solution.

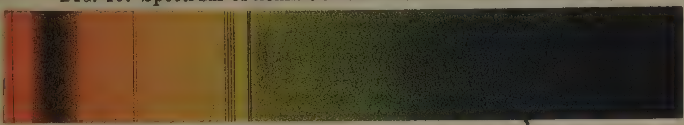
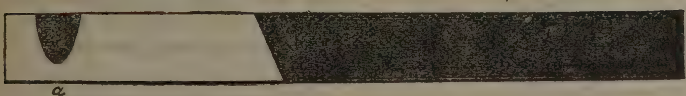


FIG. 20. Schema of spectrum of hemine.



A concentrated solution of hemine in acetic acid remains unchanged for 24 hours, but the same solution mixed with water, for spectral analysis, deposits a brown flocculent matter over night and becomes nearly colourless.

APPENDIX.

No. 10.
On Cholera chemically investigated by Dr. Thudichum.

As some substances were obtained from the muscular tissue of cholera patients, which showed spectra resembling urocyanine, the following comparisons were instituted :

Comparison of Myochrome, the colouring matter of Muscles, and its derivates with the Spectra above considered.

A man in collapse died August 20, and was anatomically examined August 21. The pectoral muscles, which were dense and pale, were excised free from blood and extracted with water. The albumen was precipitated by heating to 70° C. in the water-bath. The colouring matter remained in the solution, which was analysed before the spectroscope. It showed the blood or hemochrome spectrum.

First band in yellow, 141° 54′ — 141° 30′ = 0° 24′.

Second band in green, 141° 24′ — 140° 54′ = 0° 30′.

Green feeble blue, cut off at 138° 54′.

Consequently the choleraic process had not changed the myochrome in its chemical composition. And the identity of the spectrum of myochrome, which includes the identity of the chemical constitution of myochrome with that of hemochrome, was anew demonstrated. To this solution acetic acid was given, whereupon an absorption band appeared in red to orange, narrow at first, measuring 142° 18′ — 142° = 0° 18′, growing broader, 142° 24′ — 142° = 0° 24′, while the blood or myochrome bands grew narrower and paler, measuring, first in yellow, 141° 54′ — 141° 36′ = 0° 18′, second in green, 141° 24′ — 141° = 0° 24′. The addition of acetic acid in excess produced the complete disappearance of myochrome bands, and the establishment of a band of myohemine, measuring 142° 42′ — 142° 12′ = 0° 30′. This band, therefore, is of the same width as that of blood-hemine, but is moved 0° 6′ farther towards the red end of the spectrum than hemine. Future researches must decide the question which arises regarding the meaning of this curious displacement.

We have therefore here a number of chemical bodies possessing strong chromatic powers, which in their optical properties resemble very much the blue and red matter obtained from cholera-urine. But the spectrum of no one body is identical with the spectrum of any other, and consequently we are constrained to admit that they are all of a different atomic constitution. By the width of its band, urocyanine resembles most to indigo, but the shading of the green and absence of the blue from the urocyanine spectrum distinguish it strikingly from indigo, and approach it to the spectra obtained from hemo- and myochrome, most of which are cut off at or near to the b line of the solar spectrum.

The urocyanine of cholera-urine is present in such small quantities that we can never hope to obtain insight into its composition and atomic weight by direct analysis, but the information wanted has to be obtained by synthetical comparisons, such as those above instituted.

If we arrange the spectra ascertained above in the order of their succession from the red end towards the violet, we get the following instructive list :

Myohemine - -	142° 42′—142° 12′=0° 30′
Hemine - - -	142° 36′—142° 6′=0° 30′
Urocyanine - -	142° 30′—141° 54′=0° 36′
Indigo - - -	142° 24′—141° 48′=0° 36′
Urorubine - - -	142° 24′—141° 54′=0° 30′
Hematine - - -	142° 18′—141° 48′=0° 30′
Cholocyanine - -	142° 6′—141° 48′=0° 18′
Cyanine - - -	142° 12′—141° 20′=0° 42′

The last-named body, a double base, obtained from animal oil, but containing iodine, possesses a spectrum which in several respects resembles

the spectra, below which it is ranged for the purpose of illustration and comparison. The alcoholic solution has the same purple blue colour as urocyanine, but, unlike this latter, it is easily and rapidly discoloured by acids. Like indigo it has the blue part of the spectrum bright and fully developed, and differs by this peculiarity from urocyanine and the hemochrome products.

I have compared many more substances with those above mentioned. Organic colouring matters, particularly some from plants, yield spectra much resembling the hematic series, e.g., tincture of privet berry, which gives almost the hematine spectrum. Inorganic bodies, such as oxalic solution of Prussian blue, yield no separate bands, but peculiar absorptions, particularly of the red end of the spectrum. As these researches fail to throw any further light upon the particular point here enquired into, they cannot be here related.

E. CLINICAL OBSERVATIONS BEARING UPON THE LAWS OF TEMPERATURE IN CHOLERA.

(*a*.) *Abstracts of Cases upon which Observations of Temperature, &c., were mnde.*

1. *Charles Bacon*, 34.—Was admitted Aug. 30, and remained in hospital until Sept. 8. A mild case. His temperature never left the limits of the fluctuation of health, so that it is probably only the stage of reaction during which observations were made upon him. The algide stage was short, and, as in many similar cases, had passed over before his admission to the hospital. The observations were continued during five days only, the rest of his stay in the hospital offering no particular features. On the first two days, T P and R show a remarkable similarity in their movements; the great fall effected on the second day is maintained in the tendency of the third and fourth day. A rise in all functions during the night from the fourth to fifth day left the patient well.

A mild case observed in reaction only. Compare Table 1.

2. *Robert Baxter*, 55.—Was admitted Aug. 26, and remained nine days in hospital. He had had rice-water discharges, cramps, and lividity of face. His pulse was good. He was a fisherman and had been seized on the Thames 10 miles below Gravesend. He made a good rapid recovery, although a period of obstinate constipation succeeded upon the purging. He was found to have an almost normal temperature on admission. On the second or third day the temperature fluctuated within natural limits, though with a decided downwards tendency, in which P and R clearly joined. On the fourth and fifth day all three functions sank considerably; on the evening of the sixth, however, they effected a simultaneous rise, after which on the seventh and eighth they assumed almost normal height and frequency.

Observed in reaction only. Compare Table 2.

Lowest T on fifth day.

3. *Mary Bennett*, 30.—Admitted Aug. 12, 11.30 a.m., after 22 hours of purging and vomiting. Cramps and rice-water stools had appeared on morning of admission. Her pulse was fair and her surface warm, although her voice was weak and her aspect choleraic. On the morning of the 14th she apparently got out of collapse. (I did not obtain any urine from this patient and do not know whether she passed any.) But T R and P sank again simultaneously at night. Another simultaneous rise took place on the fourth day, but resulted in a great fall in the night following. On the fifth day in hospital a slight simultaneous rise ensued followed again by a deeper sinking. On the sixth day a considerable rise was followed by a greater fall on the seventh, when the T and P and R reached the minima of all observations; a few hours afterwards the patient died. The rise of all functions during a short period

Collapse. Attempted reaction. Sinking of all functions. Death. Compare Table 3.

of the agony is remarkable. The temperature of the body rose slightly after death. This circumstance has to be explained as the result of the cessation of the abstraction of heat by respiration. The heat already formed at the moment of death, or in process of formation, has time to accumulate for a short time, after which the body rapidly cools down and assumes the rigor of death.

This case might be characterized as one of death in protracted collapse.

Collapse. Abortive reaction. Death. Compare Table 4.

4. *Richard Benham*, 6.—Was admitted Aug. 19, having had 14 days diarrhœa. He had vomiting and cramps, his pulse was small, surface cold. Complained of thirst. The vomiting and purging of rice-water continued for two days, during which he slept much. His respiration became rapid, and there were mucous râles in chest. He died during a reaction of low type. T in collapse remained much below the normal, while P and R were remarkably accelerated. The abortive reaction brought the T once to the normal, but with asphyxia and rapid R the T sank again, rose slightly in agony, and a little more immediately after death. There was a remarkable similarity in the movements of the three functions on the three days of observation. The width of the fluctuations in P and R are very striking, and indicative of the pulmonary lesion to which the patient mainly succumbed.

Collapse. Reaction, with almost normal T. Compare Table 5.

5. *John Berentz*, 24.—Admitted Aug. 20. Remained in hospital until Aug. 31. Was a sailor from the ship Allen. He had had diarrhœa for three days, cramps and choleraic aspect were marked ; his tongue was moist and white. He became worse in hospital and voided the stools characteristic of cholera. The cramps became violent, but he made a fair recovery. It is evident from a contemplation of the table, that although the general history relates that the man got worse in hospital, he nevertheless intrinsically improved from the moment of his admission. For his T rose immediately, while P and R both sank towards their normals. In this case, therefore, physical diagnosis gave more accurate data than the feeling and general aspect of the patient, or the fact of his voiding characteristic matters. From the second day the T ranged within normal limits, with no extraordinary fluctuations. On several days the resultants of the curves of the several functions showed a striking similarity.

Collapse. Protracted, vomiting, low T, sudden rise. Compare Table 6.

6. *William Blackhall*, 29.—Admitted Aug. 11. He was taken early on the morning of the 11th, with vomiting, purging, and cramps in the legs. On admission his eyes were sunk, hands cold, pulse feeble. On the same evening the collapse passed off, and he became warm, with good pulse. From the 12th to the 19th he was incessantly retching, and vomiting everything he took. On the 19th the sickness yielded to a hydrocyanic acid and bismuth mixture, aided no doubt by the rise in the temperature of the body which had begun the previous day. On Aug. 21st, a sudden rise of three degrees in his temperature took place, accompanied with a slight quickening of the pulse. There was nothing in the patient's general condition to account for this phenomenon. The downwards sweep of the three functions on the third and fourth day was very conspicuous. From the fifth to the ninth day the T gradually rose, but sank again, to rise above the normal on the 11th day. The simultaneous rises of the three functions on the sixth, seventh, and ninth day all indicate abortive attempts at reaction ; thermically the collapse lasted until the 11th day, on which an energetic reaction carried the patient into convalescence. On 10 days the patient's T was much below the normal, on one above, and on the two last days it kept at the normal average height.

Diarrhœa, collapse. Reaction.

7. *Henry Branch*, 29.—Admitted August 9, at 9 a.m. He had been attacked with severe diarrhœa at 2 a.m. the same morning. At 8 a.m.

he applied at the hospital for medicine, but refused to stay in. At 9 a.m. he was brought back in full collapse; sunken eyes, lividlips, cold hands, feeble pulse, and husky whispering voice. On the 10th he had severe cramps. On the 11th, in the morning, reaction set in; he became warm, and his pulse good. He continued in a very depressed state, complaining of great headache and pain in the chest. However, on the 15th he rallied, and entered on a slow but steady recovery. The depressed condition in which the patient continued for the first four days of T observations may perhaps with propriety be termed a lingering collapse. On several days the lines of the three functions showed a simultaneous tendency to rise and fall. R repeatedly rose a four hour period earlier than T and P. The R on the whole remained low, and the P never rose to 100, so that the case was evidently one of no very great severity, though protracted through 14 days.

APPENDIX.

No. 10. *On Cholera chemically investigated by Dr. Thudichum.*

T observed in depressed state after collapse and in reaction only. Compare Table 7.

8. *Joseph Brown*, 28.—Admitted August 22nd, remained nine days till August 31. Had 24 hours' diarrhœa. He complained of sickness and thirst; his eyes were a little sunken, and his surface was cool, but his pulse was fair. This was a mild case, which was remarkable mainly by an extraordinary rise of temperature to 39·4 during reaction, without any deleterious effects. This absence of consequences of the febrile state is mainly accounted for by the constant tendency to sinking exhibited by the pulse. On the fourth day of the table the three functions acquire a remarkable parallelism, which is still more striking on the fifth, and on the sixth leads to recovery.

Mild case. Reaction only observed. T rose once to 39.4. Compare Table 8.

9. *Nora Buckwheel*, 10.—Very mild case of cholera, admitted as diarrhœa. While in the hospital purging of rice-water stools came on, whereupon the observations recorded in the table were begun to be taken. The collapse was scarcely marked at all, and there was very little to indicate the case as one of cholera except the rice-water. In a few days she got quite well. Throughout the observations contained in the table the three functions observed considerable parallelism. The temperatures were mostly below, few upon, the line of the normal average.

Very mild case. Collapse not marked. Compare Table 9.

10. *Rebecca Cohen*, 2 years 8 months.—The child of a hawker; came to hospital on August 16, and remained till 23rd. She was admitted cold and with sunken eyes; her pulse was weak, and she vomited. Her brother had died in the hospital on the previous day. The patient had a warm bath on admission, after which reaction set in. Purging ceased on the first day, but obstinate vomiting continued for two days; castor oil had twice to be given to overcome the torpidity of the bowels. The child recovered completely. The temperatures are all those of reaction only, but they remained below the normal average, with one exception, which fell upon the normal line.

T observed from stage of reaction only. Compare Table 10.

11. *Joseph Darleston*, 36.—An engine fitter; came to hospital on August 30, in reaction. Remained 10 days, and left completely restored, his illness having throughout shown a mild character. The temperature was at first below but rose afterwards above the normal average.

Mild case. Reaction. T below and above normal. Compare Table 11.

12. *Charles Face*, 21.—A sailor; had had previously diarrhœa. On reception into the hospital he had cramps in legs, and his eyes were sunken; his pulse was feeble, but there was no lividity. The violent cramps were relieved by continuous currents of electricity. He had a strong reaction and made a good recovery. If we accept the first observation 34·9 as the end of collapse, and the subsequent great rise as the beginning of reaction, then reaction on the next three days remained of a low-temperatured type. The steady sinking of P and R allowed to foresee the rise of T on the fifth and sixth day. The case terminated in recovery, without any febrile excitement. A regular sinking of T. took place almost every evening during the hours from 6 to 12.

Collapse. Reaction, with low T rising gradually to normal. Compare Table 12.

Appendix.

No. 10.

Very slight case. Recovery. Compare Table 13.

13. *George Edward Field*, 9.—The child of a nurse, received August 16, after seven days' diarrhœa. He had cramps in legs, a small pulse, and the choleraic aspect. Although a distinct case of cholera it was a very slight one, and the child made a rapid recovery. On the first day the pulse was rapid, while T was a little below normal; T soon rose above, and at recovery fell again below normal. Remarkable parallel and simultaneous rise and fall of all three functions on second day of observation.

Compare Table 14.

14. — *Gardner*.—No notes about this case in hospital records. From the table it is seen that this was a case of asphcytic collapse, with greatly quickened R. T fluctuated considerably, rising in asphyxia to 37·4, and sinking immediately to 35°. The observations indicate a fatal case.

Reaction complicated, with convulsions and abscesses in parotid glands. Death. Dropsy. Compare Table 15.

15. *John Hammond*, 7.—Admitted August 8th, 8.40 p.m. Diarrhœa began on the morning before admission, purging, vomiting, and cramps on the morning preceding admission. On admission had cholera aspect, but was warm, with fair pulse. Had little vomiting or purging while in collapse. Reaction began on the 11th. Remained in a febrile state, with quick pulse, pale, scarcely conscious. On the 16th the parotid of the left side with the sub-maxillary gland began to swell. Febrile symptoms increased. On the 18th spasms of the feet and hands came on. The right parotid began to swell also, and soon both glands showed abscesses, which had to be evacuated by incision. On the 20th he began to have very frequent epileptiform fits, followed by extensive dropsy of feet and legs. On the 23rd appeared better than the previous day. The spasm of the hands passed off, that of the feet remained. On the 24th he became unconscious shortly after midnight; the dropsy increased, pulse extremely feeble and rapid. Breathing with extreme difficulty. Died at 12½ midday. The series of observations only refer to the stage of ultimate reaction. The T obs. are mostly above normal, reaching 38·8 in two days; with the convulsions the falling to normal T which had taken place ceased; T rose during five days, until it reached the high point of 40·9, shortly after which the patient died. From these phenomena it is probable that the T during collapse was extremely low.

Collapse. Reaction. Recovery. T throughout below normal. Compare Table 16.

16. *Denis Healey*, 25.—Was seized on the morning of August 11th, without having had prodromary diarrhœa, with severe purging of watery motions and vomiting, rapidly followed by cramps in the legs. On admission in the afternoon of August 11th, eyes were sunk, breath, tongue, and hands cold. Pulse fairly good. Very violent cramps came on and continued throughout the night. On the morning of August 12th he was getting out of cold collapse, warm, and the cramps entirely ceased. Passed first urine. Made a rapid and complete recovery. In this case the T of collapse rose to within the lower range of normal fluctuation, but never to the normal average, except on one occasion on the last day but one. R and P exhibit a steadily decreasing tendency.

Four days T almost normal, but ranging more down than upwards. Compare Table 17.

17. *Kate Holland*, 9.—Very mild case. For the first day her hands were cold, her eyes a little sunk, her pulse feeble. She complained of head ache and noises in the ear. The second day she was very drowsy, and on the third day she recovered. In a short time she was quite well. The T of this patient remained almost normal in the daytime, but sank every night a degree more or less below its day point.

Severe typical case of collapse and reaction. Compare Table 18.

18. *Charles Jackson*, 12.—Admitted August 16th. Had had four hours vomiting and purging, but no cramps; his eyes were sunken, his tongue was cold and foul, and he was pulseless. Cramps came on after admission; the pulse became intermittent. He was very restless during reaction, but made a rapid recovery. This case is typical of

severe collapse, with asphyxia, of rapid reaction with great perturbation of the respiration and circulation. But at no period of reaction did the temperature rise above the maximum of health, and kept generally below the normal average. This is perhaps explained by the fact that the collapse was only of short duration.

Appendix. No. 10. On Cholera chemically investigated by Dr. Thudichum.

19. *Joseph Jackson*, 8.—A dirty and neglected little boy, brother of the foregoing patient, was admitted August 19th, and remained 13 days. He had vomiting and purging, and the features of cholera were well marked upon him. He made a good recovery. In the algide stage his temperature sank to 36, but quick reaction setting in, it rose on the day after his admission to 37·5, his P at the same time beating 140 times per minute. T, P, and R sank on the third day, and on the fourth all functions assumed normal conditions.

Not a severe case. Collapse and Reaction. Compare Table 19.

20. *Henry King*, 48.—Admitted during afternoon of August 15th, in extreme collapse, purging of a milky fluid having begun in the morning. Tongue cold, eyes sunk, hands and lips livid, the cholera aspect well marked. Pulse very small. He soon got out of collapse, and in the evening of the 16th passed first water. From this time his progress towards recovery was regular and rapid. The T of collapse was only shortly maintained (48 hours), after which the patient quickly approached the normal average. During five reaction days his T kept mainly below the normal average, but it also reached this line and exceeded it slightly a few times.

Collapse. Reaction. Typical case of smart short cholera. Compare Table 20.

21. *Caroline Kilbey*, 32.—Reaction-stage of cholera, complicated with pregnancy and delivery. Admitted on the 11th in the stage of reaction. Her face was flushed, eyes sunk, pulse good but quick; her tongue and extremities warm. She was at full term of pregnancy, and had not felt the movements of the fœtus for five days. On the 14th in the afternoon she was delivered of a dead fœtus. On the 15th she began to be feverish, with flushed face, warm skin, and quick pulse. This continued till the 19th. From this time her recovery was rapid. On the 23rd she rose from her bed. During three reaction days this patient showed a low non-febrile T, and retained it even on the day of delivery. On the day after delivery the T rose quickly towards the febrile, reached its maximum on the second day after delivery (39·4) and thence fell during five days gradually to the normal.

Reaction complicated with delivery. Compare Table 21.

The remarkable bearing of the P seems to indicate that reaction proper had reached its end on the third day after admission. In the rise accompanying the puerperal process, P and R participate somewhat, but reach a maximum only on the fifth day after delivery. The curious particulars of simultaneous rises and falls in the three functions must be studied on the table.

22. *Charles Lomas* 28 (alias Lummas).—Received into hospital August 26, after one day's diarrhœa and eight hours' cramp. Eyes sunken; voice whispering; tongue foul and cold. His skin was bathed in cold perspiration. After admission he had one fæculent motion caused by oil, and passed some urine with it. The violent cramp was relieved by a bath. Afterwards he had some violent cutting pain in his side, which continued obstinately. He died unobserved, though two attendants were by his side.

Collapse. Reaction. Recovery. Short typical case. Compare Table 22.

There was only one observation of T made, which is recorded in the table. It would hardly be worth while to devote a table to such a case, did it not strikingly illustrate the condition of a great number of cases which were carried to the hospital in a dying condition.

23. *John Martin*, 15.—Admitted September 2nd, after vomiting, purging, and cramps. His eyes were sunken and his voice was altered. The

Compare Table 23.

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patient had suffered from fever just before, and had three sisters ill with cholera. But although severely ill he made a rapid recovery. In this case T sank during the day following admission to the minimum of 35, but thence rose within three days to the lower average of health. The mean of health was only reached once, and once exceeded. The rapid falling of the pulse is well shown by the lines on the table, the resultant being almost a diagonal of the square of the table.

Low collapse, high reaction, long, severe, and striking case. Compare Table 24.

24. *Charlotte Mason*, 8.—There were no notes in the hospital records about this case. The more eloquent is the table before us. The lowest state of collapse and asphyxia was reached on the fifth day of observation, when T was = 33·8, P nil, and R = 12 or 13. Then a rapid rise of all three functions ensued, which reached its climax on the 12th observation day, T = 39·3, R = 52, with complete asphyxia at four periods of observation. But a rapid decrease in the intensity of all functions took place the same night, which carried the patient in a few days to apparent convalescence. The pulse remained very frequent to the last observation.

Collapse and reaction, slight case. Compare Table 25.

The length and depth of the algide stage was in this case succeeded by an equally long and severe febrile reaction. The extremes of temperature were the farthest distant observed in any case ; only one fatal case of collapse had a lower, and one fatal case of complicated reaction and two cases of ordinary reaction had a higher, temperature at the maximum.

Collapse. Reaction. Lung-disease. Low T throughout. Compare Table 26.

25. *Edward Nash*, 8.—The son of a labourer, in a dirty and neglected state. Had purging and vomiting. Made a rapid and complete recovery. The lowest T of collapse was 35·2 ; on day after reaction began T rose to 37·5, and then fluctuated between the limits of health for the rest of his stay in the hospital, nine days. P required five days to sink to near normal numbers. No febrile excitement in T.

26. *Olyfes Nelson*, 33.—Admitted August 12, at 1 p.m., after a drinking bout of several days. Diarrhœa began the day before admission ; cramps, vomiting, and purging of rice-water on morning of admission. He was now in collapse ; his eyes were not very much sunk, but surrounded with well-marked blue circles. Hands very cold ; forehead cold and clammy. Tongue coated with white fur, warmish. Pulse very feeble. Was much purged during the night from the 12th to the 13th. Got out of collapse on morning of 14th, when he first passed water. But he remained very restless, his skin covered with clammy sweat, pulse feeble, very delirious. In this state he continued till death.

The chief morbid alterations were found in the lungs, and are described in the special P.M. notes. With the exception of the anterior and upper parts, the lungs were rather congested, œdematous, very rotten, presenting patches of soft rotten hepatisation, breaking down with abundant effusion of pus. At either apex was a large patch of greyish almost white hepatisation extremely soft.

This man may be said to have died from mortification of the lung-tissue consequent upon the low temperature of collapse. His temperature remained throughout very low, yet his respiration was exceedingly frequent, without cough or bronchial irritation. There was considerable parallelism in R, P, and T on several days, particularly August 13th, 16th, and 17th. The temperature rose during the agony, and immediately after death was nearly a degree higher than when it had last been taken shortly before. Throughout the entire illness the patient's T kept below the lower limits of health.

Collapse. Death. Breath smelled

27. *Mary A. Reed*, 70.—Was admitted Aug. 27th. Had been well up to 10 p.m. on 26th, and came to the hospital four hours later, at 2 a.m.,

vomiting much unmasticated food. She was given a dose of castor oil, which remained in her stomach, and she thereupon went home. Watery motions appeared, and she was brought back at 10 a.m., in collapse. She gradually became worse during the day; at 11 p.m. her breath was observed to have an odour of rice-water. She remained conscious, but died before morning. Her T on admission was 34·5, at death 34·6. During the night T had once risen to 36·1.

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Breath smelled of rice-water. Compare Table 27.

28. *Napoleon Reed*, 22.—A stevedore, was admitted Aug. 25th, after four days' diarrhœa. After admission passed rice-water stools. The case was mild, and made a rapid recovery. T in the algide stage only sank to 36·1, and in reaction rose to maximum 37·2. The rest of the time it remained upon or a little below the normal average.

Compare Table 28.

29. *John Ribocq*, 66.—Was taken at 6 a.m. of the morning of admission with purging of rice-water, vomiting, and cramps. On admission his face and hands were very livid, his eyes much sunk, surface cold. Pulseless. He got a little better, warmer, and a feeble intermittent pulse could be counted. On the 20th he was very restless, tossing about, obtusely conscious, covered with a cold clammy sweat, pulse extremely feeble. He died about 6 p.m. His T on admission was 32°9, rose later in the day to 34°4, and during the night to 35°7. But in the morning it sank again to 34°5, and death ensued with a T of 34°7. This man exhibited the lowest T of any observed.

Collapse. Lowest T observed. Death. Compare Table 29.

30. *Anne Rosedale*, 44.—A married woman, was admitted Aug. 18th. She had vomiting and purging, ultimately of rice-water, but no cramps. She was at the same time suffering from syphilis. Quinine and iron acted beneficially, and she recovered quickly. On account of the collateral disease she was not discharged from the hospital until Sept. 15. Her T in collapse was low, min. 34°5; on the third day she reached the normal, and fluctuated thereafter upon the mean line within normal limits.

Collapse. Reaction. Complicated with syphilis. Compare Table 30.

31. *Bernhard Scheiner*, 25.—This was a mild case. He was admitted August 12, at 8 a.m., after having had diarrhœa for 30 hours, and vomiting and cramps in legs for six. His pulse was small and feeble; his tongue furred and cold; eyes sunk and livid; but the collapse was on the whole not severe. He said he had passed water before coming to the hospital, and went at once into the state of reaction. On August 14th he passed first urine. The first urine which I could obtain for examination was from August 17th. The T of collapse was not low in this case, and rose immediately to normal; but with the sinking of P a curious sinking of T ensued on the third, fourth, and fifth day, reaching a minimum 35°, one degree below the minimum of collapse, which had been 36°. On the 6th it rose again together with the pulse, and the patient convalesced. The falling of the pulse in its resultant represents a diagonal of the square of the table.

Slight collapse. Reaction. Compare Table 31

32. *Joseph Shiels*, 11.—Was admitted on September 3rd, after vomiting and purging. He had the cholera aspect, his eyes were sunken, and his pulse was small. Although the case was severe, and the patient had had fever just before, he recovered. The lowest T of the algide stage was 36°1; the highest of reaction 37°8, neither of which far exceeds normal limits. This and the steadiness of T from the third day explain the rapid recovery. His previous illness gave the case a more severe appearance than it actually was. P much disturbed, falls in a diagonal line through table.

Compare Table 32.

33. *Emma Smith*, 32.—Admitted August 12, 8.30 p.m., after three days' diarrhœa, and since the morning purging, vomiting, and cramps in the legs. Eyes sunk, skin warm, pulse small. On the 13th much purging and vomiting. Towards evening she got out of collapse. During the

Compare Table 33.

following days her T nevertheless kept sinking until it reached on August 17th, the fourth day of observation, the minimum of 34°4. P then began to rise, and reached on the ninth day of observation the maximum of 38°4; thence it sank, during the four following days to the normal average. This case resembles others of our series in which reaction was accompanied at first or in its course with low temperature. The pulse after a rise on the third day fluctuated steadily towards the normal, but R rose with T, imitating its fluctuations daily, and not receding until the end.

Asphyctic collapse. Death. Low T. Compare Table 34.

34. *Margaret Spears*, 40.—Was taken to the hospital on August 27th. On the previous day she had had vomiting and purging, and had become much worse during the night. She had vertigo and noise in her ears. Her eyes were sunken, but there was no lividity; her pulse was good and her voice not altered. She was much relieved by a bath, but the cramps again returned. Dr. Beigel tried hypodermic injections of warm water, with some appearance of relief. They were repeated four times, but the patient gradually sank. The bowels were distended with flatus, and she experienced a constant desire to pass water, though the bladder, as was proved by examination, was empty.

This person, a widow, was a nurse to cholera-patients, and like her sister fell a victim to her calling.

Her pulse was observed to be beating at three periods of observation, while at six other periods the patient was found to be asphyctic. Her T fell from 36°3 on first day to 34°7 on second, and shortly before her death rose almost one degree.

Compare Table 35.

35. *Henry Taylor.*—This patient was only observed in a state of reaction, having just got out of collapse. Admitted on August 11th, 6 p.m., having had rice-water purging, vomiting, and cramps on the 9th. At the first observation he had a warm skin and a fair pulse. He went on very favourably towards convalescence, without any complication whatever. There was a remarkable parallelism of T, P, and R on the third and fifth day of observation. The T fluctuated within at first narrow, afterwards wider limits, both being almost or entirely within those of health. Maximum 37°6, minimum 36°.

Collapse. Reaction. Great extremes of T. Compare Table 36.

36. *Marianne Tonzel*, 11.—The child of a stevedore, came to the hospital on August 26th. She was in great collapse, with small pulse and pale face. Sickness and purging continued. She was much improved by baths and made a rapid recovery. Her T at the lowest of collapse was 34°2; it rose somewhat, but during four days kept below the normal average; on the fifth day it rose above the normal, and remained there for three days, on the third reaching 38°4. The rise in T on the fifth observation day was accompanied with a similar increase in the R, and particularly the pulse. On the whole there is remarkable coincidence in the fluctuations of the three functions. The case resembles much the cases of Blackhall, Smith, and Mason, in the great difference exhibited by the maximum and minimum T, and in the circumstance that reaction was for a considerable time carried on at a temperature below the normal average, but afterwards at a T approaching the febrile state.

Collapse protracted, or passing into typhoid condition. Death. Compare Table 37.

37. *Jane Turnbull*, 44, married.—Admitted August 6th, in a state of extreme collapse, after about six hours of severe vomiting and purging, followed by cramps. The attack preceded by three days' diarrhœa. She got slowly out of collapse, but fell into a typhoid state. During the observations recorded in the table she exhibited extreme depression and increasing unconsciousnesss. Pulse feeble, intermittent; tongue

dry and brown. These symptoms increased up to her death on the morning of the 15th. The post-mortem examination was made. Her temperature for two days was much below the normal, but during her last 12 hours it steadily rose to almost the normal height. Minimum 34°4 on first and third day, maximum 36°4 shortly before death. Parallel progress of the three functions.

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38. *Celia Turner*, 8.—A very mild case. Vomiting and purging of rice-water stools, but the symptoms of collapse never well marked. The recovery was rapid and complete. P enormously accelerated, but falling to normal in three days. R and T also fell rather than rose in reaction. T remained throughout below normal average.

Very mild case, T below normal, R also. Great cataract of P. Compare Table 38.

39. *Jane Vowles*, 2.—Very mild case; admitted August 20. Purging and sickness began on afternoon of 17th. On admission, surface warm, eyes much sunk, pulse distinct but quick. Eyes remained sunk till the 22nd. Ill about three days. On the 20th she was depressed, in slight collapse; on the 21st she was rather feverish and sleepy; towards the afternoon of the 22nd she was lively, and appeared pretty well. Her T varied between narrow limits, and indicated a slight case. Min. 35°9 once, max. 36°9 also but once. All observations of T but two, that is 19, were below average normal, and rather below the lower limits of healthy fluctuation. The perturbations of P and R are very conspicuous, as also the circumstance that during convalescence P remained much accelerated.

Mild case. Great perturbation of P, and R T rather below normal. Compare Table 39.

(*b.*) *Summary of Results of Clinical Observations bearing upon Laws of Temperature in Cholera.*

The temperature of cholera patients as measured in the axilla hereinafter (for brevity denoted by the letter T) falls from beginning of severe symptoms steadily from the normal 36°8 Centigrade to a figure 3° or 4° below that, 32°9 being the lowest observed in any case. The rate at which, during the first stages of the choleraic process, T sinks to the lowest of collapse, is in most cases very rapid. But no particular observations could be made, cases not coming under observation in those stages.

External temperature of body falls.

The lowest T is quickly reached in deepest collapse. The minimum T. of all cases observed in the algide stage are below the lower limits of the fluctuation of health. (See table 40.)

T lowest in collapse, Minimum.

The maximum T. of the majority of cases observed are below the upper limits of the fluctuation of health. This is clearly exhibited by table 40, which, together with the 39 special temperature tables, should be consulted for a verification of these theses.

Maximum T of majority of cases.

The lower the T, and the longer the duration of the algide stage the higher and the longer continued is, on the whole, the T of the tepid stage.

Extreme T often in the same case.

The T of the tepid stage does not exceed the upper normal, unless the T of the algide stage had previously sunk below 35°. But the T may for a short time reach 35° and less, and yet the T of the tepid stage not rise above the upper normal.

T of tepid stage.

When the maximum T of a case of cholera remains throughout below the normal average, the case will probably be fatal. Among the 39 cases observed all such cases, seven in number, proved fatal.

Prognosis from low maximum.

On the basis of the thermometric observations cholera may be divided into two stages; the first or algid stage, from the beginning of symptoms to that period where T reaches again the normal limits or average; and the second or tepid stage, in which T either remains

Thermometrically cholera to be divided into two stages, the algid and the tepid.

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within the normal limits or rises more or less above them, in some cases even to febrile height, afterwards descending again to normal limits.

Clinically cholera to be divided into seven stages. All stages do not occur in all cases. Influence of T of external air not perceptible in these observations. Prognostic value of minima and maxima of T.

But on the basis of all the pathological phenomena and clinical data we can distinguish, and it is of advantage to do so, the following seven stages of cholera :—(1) *Fœcal diarrhœa ;* (2) *Choleraic diarrhœa and vomiting*, quick sinking of T ; leading to (3) *Asphyxia or collapse*, in which lowest T is reached ; (4) *Reaction*, which may be defined as the cessation of collapse and the beginning of the re-establishment of the suppressed functions ; (5) *Torpid stage*, or secondary period of algid stage, in which, reaction notwithstanding, T remains below the lower normal limits, and then gradually or suddenly rises to the normal average ; (6) *Tepid stage*, in which, during continued reaction, T rises to normal or its upper limits, more rarely somewhat above ; (7) the *febrile stage*, only reached in cases where the entire algide stage has been very long, or where there are complications, or secondary lesions arising out of the choleraic process. Reaction does not always terminate the algid stage. For although, from the moment of the beginning of reaction T rises somewhat in most cases, in exquisite cases it does not reach the lower limits of normal fluctuation. The algid stage is evidently continued into the state of reaction, and the tepid stage is the result only of continued reaction. Reaction begins mostly with absorption from the intestinal canal within 36 hours from collapse, possibly also with some actual secretions.

All the above stages are represented in the tables, but the first two stages are the least well observed. The first and seventh stage are mostly or frequently absent, the second stage not rarely very short. The secondary period of the algid stage, the torpid stage, No. 5, may be very long or very short, and in very mild cases almost imperceptible.

The influence of the T of the external air upon the T of the choleraic process was imperceptible during the observations recorded in the tables, as its range was very equable during the time of observation, the wards being mostly at 19° or 20° C.

The lowest T observed in any case when recovered was 33°8. It is at present uncertain whether there is a minimum T below which the body (axilla) cannot be cooled down without fatal results. If there is such a T it will probably be about 33°5. A low minimum T is at present of less significance than a low maximum. All cases of cholera, the T of which ranges persistently below the lower healthy limits, even if no very low minimum T was reached, seem to have a fatal prognosis.

Note by Medical Officer.

[It is all-important to remember that the thermometric observations recorded in this instructive section of Dr. Thudichum's report are exclusively of *external* temperature. In order to a complete understanding of the thermal phenomena of cholera, observations of this kind require to be supplemented by observations of *internal* temperature. And I therefore refer to some such, which have been elsewhere recorded.

In 40 cases of collapse treated in the London Hospital in the late epidemic, temperatures were measured, simultaneously in the rectum or vagina and in the axilla, by Mr. F. M. Mackenzie, assistant resident medical officer of the hospital.* Another important set of double

* Mr. Mackenzie's notes of these observations are among the interesting papers to which I have already referred as published in the last (third) volume of the London Hospital Reports. Besides his observations, others, also made in the East London epidemic, are mentioned more or less fully in the same volume : viz., a few made in the London Hospital by Messrs. McCarthy and Dove, and some made in the Wapping Cholera Hospital by Dr. Woodman and Mr. Heckford.

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observations, simultaneously external and internal, has been published in Germany (Virch. Arch., Jan. 1867) by Dr. L. Güterbock, who, during the epidemic in Berlin had charge of the Cholera Hospital No. II. The hospital, within about 10 weeks, received 820 cases of cholera; and Dr. Güterbock's published tables refer to 45 cases of collapse which terminated fatally without reaction, to 10 cases of collapse which went on without secondary disease to recovery, to 23 cases which had longer or shorter periods of secondary disease, and, finally, to 12 cases specially observed during the process of death and for some hours afterwards. He also gives a summary of numerous observations similarly made, but with exclusive reference to collapse, by Professor v. Gräfe, in the Cholera Hospital No. IV. From all the above very instructive observations, it results, in my opinion, quite conclusively that the choleraic affection of the bowels is a heat-making or "inflammatory" process; on which the development of inflammatory fever, by circulation of blood from the inflamed part, would, as a matter of course, manifestly attend, were it not that circumstances special to the disease (circumstances which in this context may be deemed accidental) suppress or circumscribe the manifestation. In a typical case of collapse the axillary thermometer shows a temperature perhaps little above F. 90°, while a thermometer in the rectum or vagina is marking a temperature high above the normal. With the superficial pulselessness of collapse before one, the suspicion cannot fail to arise that this vast difference of temperature between external and internal parts denotes mainly the failing blood-supply of the former; a state which, in so far as it does not equally affect all parts in the aortic circulation, nor even necessarily all external parts in that circulation, may not improbably be deemed to depend, to some extent, on the muscular contractility of peripheral arteries. The suspicion that the specially cold parts of the body are thus cold by reason of their anæmia, and that the anæmia is not a mere passive result of failing heart-power, is greatly confirmed, as one observes that the difference of temperature between external and internal parts tends to be abated, not only when salutary reaction occurs, but equally when the collapse is tending to a fatal termination, and then even beyond the moment of death. In some such cases, though but in few, the external parts of the body will even assume a febrile temperature. See also preceding note on collapse.

It would be of immense interest, were it possible, to know the temperature of the circulating blood, during collapse, in parts remote from the inflamed intestinal canal; to know it, for instance, as to the blood in the aorta and left side of the heart.* It is certain that the intestinal process is of a kind to excite inflammatory fever, and it is certain that in external parts of the body febrile phenomena are (as a rule) not manifested. Is this only because their blood-supply is cut off? Or is it in any degree the index of a fallen general temperature of the blood? The question cannot at present be fully answered. Two antagonistic influences are at work, and in most cases we cannot tell which of them is predominant. On the one hand there is the calorific power of the

* The vagina, in which so many observations have been made, is of course physiologically remote enough; but its anatomical nearness to the rectum always suggests the doubt whether its high choleraic temperature is transmitted from the hot fermenting rice-water of the bowels. It deserves notice in this point of view, that, in Professor v. Gräfe's observations, the vaginal temperatures seemed higher than the rectal, which they could not have been if the vagina had got its heat from the rectum. It is true that probably the two measurements were not simultaneously made: but as against any fallacy in that respect, it is recorded that *always* the vaginal temperature was the higher, and the summary of the observations even shows that the coolest vagina was warmer than the average rectum.

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local process, of which however a very large proportion is of course wasted in the defluxions; and on the other hand there is the general arrest of chemical processes elsewhere in the body. In some cases it seems certain that the temperature of the blood is reduced, for sometimes, though very rarely, even rectum and vagina are cold; but generally the great difference on which I have commented exists, and then it must be deemed a moot question whether the general temperature of the blood is not febrile.—J. S.]

No. 11.
Professor Hallier on Cholera Fungus.

No. 11.—ABSTRACT (by DR. BUCHANAN) OF PROFESSOR HALLIER'S RECENT RESEARCHES INTO THE NATURAL HISTORY OF THE CHOLERA CONTAGIUM.*

Hallier's observations were made on the stools of a person ill with cholera at Berlin in 1866, and on the stools and vomita of a cholera patient at Eberfeld in 1867. In the stool from Berlin, the characteristic vegetable elements consisted of a fine fungiform matter (Hefe) which floated, and of more highly developed spore-cysts (Früchte) which sank to the bottom. These spore-cysts are described as yellow or brownish bodies, consisting of a pale membrane enclosing highly refracting coloured spores. The cyst wall undergoes a series of changes, ending in its rupture or solution, and the spores then become free. The spores, by progressive partition (a process which may begin before they leave the cyst) resolve into very small cells, grouped into balls and heaps which Hallier calls "colonies" of micrococcus. The small cells of micrococcus constitute the fungiform matter (Hefe) which is the other vegetable element seen in the evacuations. The minute micrococcus cells attach themselves to any bodies there may be in the stool—to remnants of animal or vegetable food, to epithelium cells, or to oil globules; and under the influence of the micrococcus, these and all nitrogenous matters got a dirty aspect and lost their structure.

Vegetable elements in stools.

Besides these two elements, torula-like bodies were found in smaller number, and were shown by experiment to develop from the micrococcus cells; nuclei growing within the ball or heap, and sometimes constituting its greater part. Around some of these nuclei a very delicate cell-wall may be found; but, to detect this, glycerine must be employed, water having a refractive index too close to that of the cell wall. The formation of these cells, which occur singly or in rows, marks a step towards a higher development of the micrococcus—towards the production of oïdium forms.

In the stool and vomit from Eberfeld, the cysts and fungal colonies were found in smaller proportion, and the free micrococcus cells more abundantly, and epithelium was seen in which the process of invasion by the micrococcus could be watched. The little cells fastened themselves upon the epithelium and increased in size as the epithelial elements wasted; in the same way that Hallier has always found fungal parasitic cells to grow at the expense of a nitrogenous organic substance which they attack.

Cultivation experiments.

Hallier next made observations on the artificial cultivation of this cholera fungus upon various soils.† He first employed a solution of sugar,

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* Das Cholera-Contagium: botanische Untersuchungen, Aerzten und Naturforschern mitgetheilt: von Dr. Ernst Hallier. Leipzig, 1867.

† For an appreciation of the care taken by Hallier to prevent the accidental introduction of other fungi into his experiments, for an account of his method of experimenting and of the check-experiments which he employed to detect possible error, reference must be made to the original paper and to the Gährungsercheinungen of the same author.

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conducting the experiment at a temperature of 68° – 88° Fahr. Here he succeeded in growing from the elements before described a long pale filament containing granular plasma, and divided by septa; from this elongated processes branched off, and the whole formed a structure greatly resembling the oïdium lactis. This oïdium plant bore at the ends of its branches bulbs (*macroconidia*) either single, or in shorter or longer series: if single, generally larger, and apt to develop *mucor*-forms, but, if in series, apter to develop *penicillium*-forms. On the 9th day of the experiment, some of the branches bore a cyst containing spores, pale and weakly. Only once did a well developed coloured spore-containing cyst make its appearance, and Hallier's experience led him to connect the absence of such cysts with the absence of nitrogenous matter from the soil in which the fungus was growing.

A variation of the experiment by providing the fungus with starch-paste produced scarcely different forms; but a more interesting result came of the addition of a small quantity of tartrate of ammonia to the paste. For the first few days of this experiment nothing but micrococcus cells, and chains of similar elements resembling leptothrix, were seen; but about the fifth day there appeared a small brown speck in the paste at some little distance from the surface at a spot where the reaction was alkaline. This brown spot gave to the microscope coloured forms; filaments, bearing macroconidia, single and in series, and some of them also bearing bunches of spores, or well developed cysts containing spores and greatly resembling the cysts found in the original stools. Upon the occurrence of an acid reaction in the paste the growth of these bodies ceased.

The cholera fungi were further grown upon muscular tissue immersed in sugar solution. The micrococcus cells were seen enlarging and budding, and developed the usual oïdium plant with conidia at the ends of its branches. Shortly after numerous cysts appeared which went through the same changes as the cysts in the original stool. The muscular fibres were invaded and decomposed by the micrococcus just as the intestinal epithelium had been in the stool.

A subsequent observation made with cholera fungi grown in the author's isolation-apparatus upon paste which had been boiled with tartrate of ammonia, yielded a very interesting modification of the former result, inasmuch as the filamentous structure was almost wholly absent and little else was seen than highly developed cyst-formations with the contained spores in a state of actual germination, and pushing their processes through the cyst wall. This is the exact counterpart of a form known as Urocystis occulta, found in the tissues of cereals.* The observation of cysts apart from filamentous growth in this experiment is particularly instructive, as it is under somewhat similar conditions that the development of the cysts, also apart from filamentous growth, takes place in the intestine of cholera patients.

In all 22 of such experiments were made with the cholera stools, and results consistent with those above described were obtained. Hallier's experience enabled him positively to prevent, and to know that he had prevented, the accidental entrance of any atmospheric fungus into his experiments.

Nature of the fungus: its habitat and origin.

"What species is the fungus that appears as the result of these various cultivation experiments? It is that species which comprises as four of its developments the forms of Penicillium (*crustaceum*) Mucor

* A very similar form, *Urocystis intestinalis*, is found in diphtheritic diseases of the intestine.

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No. 11.
Professor Hallier on Cholera Fungus.

(*racemosus*) Tilletia and Achlya.* But in the actual rice-water stool, it is none of these four developments, but a fifth, which systematists would place under the group of Urocystis." Hallier has obtained in the course of his mycological studies oïdium plants exhibiting the other forms of growth, but he has never produced by artificial cultivation cysts of Urocystis on them, except from these cholera stools. Thus in the course of innumerable observations on milk oïdium, where penicillium and mucor were met with, nothing resembling the cyst forms was ever seen. From this and other considerations, Hallier infers that this form is not indigenous in Germany, and that it has travelled with cholera from India. In the next place, he cannot think, that the original habitat of the fungus should be the human intestine, which is under much the same conditions in India as in Europe; but he sees in the high temperature of the intestine a condition capable of maintaining this fungus in activity. A similar high temperature, as provided by the mean climate of India, and by the extreme summer climate of Europe, also furnishes the condition requisite for the development of the fungus outside the body. Thus in summer, and in summer only, in European latitudes could the fungus find in earth and night-soil the necessary temperature for its increase.†

In this connexion, Hallier points out that he has elsewhere shown that the home of all penicillium-bearing fungi is Asia. The tilletia-bearing form occurs only on wheat, which is a plant imported from Asia. Hence he infers a further probability that the cholera fungus which appears to be another development of the same species is also originally Asiatic.

Further observations as to the precise effects of temperature confirmed the foregoing deductions. Fungus, while developing Penicillium only at ordinary temperatures, was grown upon appropriate nitrogenous soils at a temperature of 88° to 110° F., and (when other circumstances were favourable) a development of cyst forms took place from the budding of the penicillium, precisely like the forms met with in the stool. A piece of intestine exposed to the action of the cholera fungus at this temperature got its epithelial elements rapidly destroyed by micrococcus. Converse experiments with low temperatures showed that the characteristic cyst-forms of cholera stools were not produced upon materials that were kept below 54° F. The inference is therefore confidently drawn that if the fungus be indeed the contagious material of cholera, cholera cannot maintain itself permanently in our latitudes.‡

Professor Hallier's inquiry is next concerned with the circumstances under which the cholera fungus, indigenous in Asia, but only travelling

* These are described as four different forms or developments of the macroconidia on the same oïdium plant.

† The conditions for the production of Urocystis appear by the experiments to be, not high temperature only, but also a copious supply of nitrogenous with some hydrocarbonous nutriment, and a high degree of moisture. But besides these conditions the reaction of the fluid was found to be important, and this again to be dependent on the nitrogenous elements of it.

‡ Other conditions under which the fungus did not grow, were, 1, a temperature over 144° F.; 2, sulphate of iron in concentrated solution; 3, carbolic acid (not the most potent agent of its kind in these experiments); 4, permanganate of potash, 5; wine (from its acidity, probably) and strong alcohol. Quinine had some influence, opium none, in preventing the destruction of animal tissue by the micrococcus. Of all experiments made to determine the power of chemical agents upon the fungus, chief success was obtained by the free acidification of the fluid. This is confirmatory of Pettenkofer's views upon the disinfection by acids of substances infected by cholera poison. Whenever the fungus grew in acid solutions it showed no cysts and no micrococcus, only penicillium and cognate forms. For fungus-destruction on the large scale Hallier would give preference to sulphate of iron. But he insists particularly on the destruction of each individual stool before mixing it with other night soil, and of course urges the systematic removal of all such matters to the field.

into northern latitudes in the bowels of cholera patients, grows in its native soil of India. He recalls the fact that other forms of the fungus under consideration are peculiar to cereal plants, and that the Urocystis with its characteristic cysts inhabits the delicate and highly nitrogenized tissues of grasses; and he asks whether the cholera cysts may not also in their native soil be parasites to some graminaceous plant, just as the form Tilletia which can exist in a European climate, is a parasite upon the imported cereal, wheat, which acclimatizes itself in these latitudes.

Suggestion concerning rice.

Herein the circumstance assumes a peculiar importance that at their first acquaintance with cholera, English physicians in India named it "rice disease," (*Morbus oryzeus,* Tytler) and connected it with a diseased condition of the rice plant. Examination into the existence of a similar fungus attacking rice in India must of course be undertaken by inquirers in that country; but Hallier makes a notable contribution to this aspect of the question by his experiments. He planted rice under conditions of heat and moisture as nearly as could be obtained like those of Asiatic rice fields, and he watered these plants with the stools and vomita whose investigation had occupied the earlier parts of his paper. He obtained in every one of these experiments positive results. Carefully taking out his little rice plants in an early stage of their growth, he made longitudinal sections of them and found fungus-threads in great numbers perforating the epidermis of the plant in several places above the junction of the rootlets. The cells as well as the intercellular spaces of the tissue were invaded, and the delicate plasma of the cells was shrivelled and coarsely granular; and by the aid of glycerine a multitude of cryptococcus cells were seen and had the same characters as when known Urocystis grows within cereal plants. Here his investigation ended, without proof having yet been obtained of the identity of the parasitic fungus with the cyst-bearing plant, but with the important result that a form of the same type, at any rate, could be produced in rice watered with the cholera evacuations.

A single experiment upon a monkey was made to determine the influence of the cystic fungi. Micrococcus colonies were observed after the ingestion of tilletia-form plants, but there was no evidence as to the nature of the fungus to which the micrococcus belonged. An exact account of the fungus forms is reserved. More experiments in this direction are required before an answer can be given to the question whether the cholera fungus is identical with the matter of contagion of the disease, and even such observations, if they are isolated, would probably be of little service. It were even to be wished, for the solution of the question, that the observation could be upon the human species. Cholera stools administered to dogs have produced results in the hands of one observer that they have failed to produce for another. The diet and circumstances of the individual, whether dog or man, must be considered before any conclusion can be come to respecting the effect of ingesting the fungus.

Disintegration of tissues by the fungus.

A most important fact to be noted in estimating the connexion of the fungus with the contagious matter of cholera, is the peculiar way in which nitrogenous matters are destroyed under the influence of micrococcus at high temperatures, and particularly that the epithelium of the intestine is destroyed by its operation. If the evolution of cholera as a disease should be through the destruction of the intestinal epithelium, no more potent agent than the micrococcus of the cholera cysts could be found to produce the phenomena of the disease.

Note by Medical Officer.

[In connexion with the above account of Hallier's researches, the reader may be reminded that for a few weeks in the autumn of 1849 we

in England had a good deal of talk of a so-called cholera-fungus. The notion was not then broached here for the first time; for, some eighteen months previously, Dr. Cowdell, of Dorchester, had sought to establish, on theoretical grounds, that cholera must depend on a microscopical fungus, absorbed through the lungs into the blood, and multiplying in the blood and bowels:* Professor Mitchell, too, of Philadelphia, had advanced a similar theory:† but the special impulse to the discussion in 1849 (from the last week of September onward) was given by certain publications of Drs. Brittan and Swayne, of Bristol, in the *Medical Gazette* and *Lancet.* These writers had for some two or three months been acting in relation to cholera as a microscopical committee for the Bristol Medico-Chirurgical Society, and in their examination of choleraic discharges had, independently of one another, observed, often in very large number, certain peculiar forms ("annular bodies," "cholera cells," &c.) which they believed to form a connected series, and to be characteristic and causative of the disease. These forms, they said, were of smaller size in the vomit than in the dejections; and Dr. Brittan, stating that he had found still smaller bodies of the same sort in the atmosphere of cholera districts, put forward a note from Mr. John Quekett, then an eminent microscopist, to the effect that he, having examined Mr. Brittan's specimens, from air, vomit, and dejection, "had no hesitation in stating that in his judgment they were successive stages of development of the same body, which he believed to be of a fungoid nature." Dr. Budd of Bristol (*Times*, Sept. 26) added that he had found the same peculiar microscopic objects "which seem to be of the fungus tribe" "in great numbers in almost every specimen of drinking water which he was enabled to obtain from cholera-districts:" a statement which appeared particularly important in connexion with the very original and remarkable views then recently put forth by the late Dr. John Snow, in a little paper, which now has historical interest, *On the Mode of Communication of Cholera:* for Dr. Snow was contending that cholera is primarily an affection of the intestinal canal; that it is excited by the accidental swallowing of contagious matter discharged from the bowels of the sick—something which, being swallowed, can increase and multiply within the stomach and bowels; and that the great agent of such infection is drinking-water. Dr. Budd in the above quoted letter, and in a pamphlet which he soon afterwards published to the same effect, brought the various views interestingly together, and recommended, as a most important precaution, the disinfection of the discharges of the sick by receiving them "into some chemical fluid known to be fatal to the fungus tribe."

Thus far the story reads as if the recent observations of Thomé, Klob and Hallier, had in substance been anticipated in England nearly 20 years ago. On fuller inquiry, however, this does not seem to have been the case; and indeed the greatest doubt must be felt whether the appearances insisted on by the Bristol observers of 1849 can in any degree claim kindred with those which are now under discussion. For within a month of the publication of the alleged discovery of 1849, the whole statement of facts was put in a totally different light by a report made on the subject to the College of Physicans, by the late Dr. Baly and Dr. Gull, with valuable assistance from Mr. John Marshall, and also by the testimony of various independent writers. Drs. Baly and Gull ended their report with the following conclusions: "Bodies presenting the characteristic forms of the so-called cholera-fungi are not to be

* Disquisition on Pestilential Cholera: London, 1848.

† On the Cryptogamous Origin of Malarious and Epidemic Fevers: Philadelph., 1849.

detected in the air, and as far as our experiments have gone, not in the drinking water of infected places. It is established that, under the term 'annular bodies' and 'cholera cells or fungi,' there have been confounded many objects of various and totally distinct natures. A large number of these have been traced to substances taken as food or medicine. The origin of others is still doubtful, but these are clearly not fungi. All the more remarkable forms are to be detected in the intestinal evacuations of persons labouring under diseases totally different in their nature from cholera. Lastly, we draw from these premisses the general conclusion that the bodies found and described by Messrs. Brittan and Swayne are not the cause of cholera, and have no exclusive connexion with that disease, or, in other words, that the whole theory of the disease which has recently been propounded is erroneous, as far as it is based on the existence of the bodies in question." Dr. Swayne, it is true, protested against the conclusions of the report, and against other criticisms which had been written on the Bristol observations : *Lancet*, pp. 530–2 : but practically no advance had been made on Dr. Cowdell's theory of the year before: for it was certain that the appearances originally described had been of the most heterogeneous variety, and nothing like proof had been offered that even any of the alleged specific forms were fungic. The general verdict of 1849 seems finally to have been accepted by the observers themselves ; for, from then to the present time, though cholera has again more than once been epidemic in England, they have not, so far as I know, ever re-opened the discussion.

Hallier (citing the Bristol observations only through the notice of them which is contained in Robin's *Végét. Parasit.* pp. 676–80) supposes that the spore-cysts which he now describes were seen at Bristol in 1849. But after going in detail through the descriptions of that period, I find myself quite unable to identify his spore-cysts either with the large "annular bodies" which Drs. Brittan and Swayne described, or with the large "cholera cells" for which Dr. Swayne alone was responsible: and of no other of the alleged cholera forms of 1849 can there in the present context be question.* I may add that the Rev. M. J.

* The large "annular bodies" of the two observers had a "peculiar cupped appearance," an "unmistakable appearance of being surrounded by a thick wall, a sharp irregular fracture, the morsels presenting in some measure the same characteristic annulus as the parent cell did." Drs. Baly and Gull spoke of these bodies as "discs with thick, elevated, and somewhat irregularly curved margins, the central area flattened and obscurely granular ;" Dr. Griffith afterwards spoke of them as "structureless discs ;" they were declared by Mr. Marshall to be soluble, some entirely, some almost entirely, in ether, and to be imitable with finely-divided cheese brought with ether under the microscope ; also, whatever may have been their nature, they were affirmed by Drs. Jenner, Baly, and Gull to have been seen by them respectively in the discharges of typhoid fever and dysentery, as well as under various other circumstances. Dr. Swayne's large "cholera-cell" was "more than twelve times as large" as the spores of uredo caries ; had a thick and commonly much laminated wall ; was "met with of all sizes and in every stage of development," was "covered somewhat irregularly with blunt projections or buds ;" contained "within it a round granular mass which does not quite fill its interior ;" and nitric acid, which "has no action on the uredo beyond rendering it rather paler, slowly dissolves the cholera-cell, first turning it a bright yellow colour, then resolving its granular contents into three or four oily-looking globules, and finally reducing its wall to a very thin pellicle with scarcely a trace of buds." Probably the latter bodies may best be identified for purposes of mycological comparison by reference to the description of them which was given, in that point of view, by the Rev. M. J. Berkeley, in the *Medical Gazette* of Dec. 14, 1849; but it seems conclusive to observe that Mr. Berkeley did not identify the "cholera-cells" as forms of cryptogamic vegetation, which assuredly he would have done if they had been such spore-cysts as Hallier represents. Any one who may wish to compare for himself the representations of 1849 with those now put forth by Hallier,

Berkeley, who is still, as he was in 1849, the first of our mycological authorities, and to whom in 1849 many specimens of cholera discharge were referred, for mycological criticism, by the Bristol observers and others, has done me the favour of looking for me at Hallier's illustrations, and informs me that the "annular bodies" and "cholera cells" which were brought under his notice in 1849 were quite dissimilar from the spore-cysts which are now brought under discussion, and that the latter are now seen by him for the first time. Mr. Berkeley also draws my attention to the resemblance of Hallier's spore-cysts to some of those which were represented by himself, in the Journal Linn. Soc., 1864, as belonging to the fructification of *chionyphe Carteri*.

A reference which in the present context seems to me to be far more important than any in the literature of 1848–9, and which I am surprised not to see prominently made by the present German observers, is to Boehm's observations of 1838.* If the doctrine of a cholera-fungus should hereafter be substantiated, it will probably be conceded that Boehm deserves the credit of having first published a thoroughly valid account of phenomena of cryptogamic vegetation in choleraic intestines and discharges, and that Hallier's researches do not better join on to the recent essays of Thomé and Klob, than they might have joined in 1838 on to those of Boehm. The fifth section of his admirable little book is entitled *Ueber das Vorkommen der Gährungs-keime* (*Pilze*) *im Nahrungs-kanal der Cholera-kranken.* In it he describes, as almost constant, that the whole extent of the intestine (but generally the large intestine least) teems with a vegetation of microfungi: that innumerable round and oval, or more elongated, corpuscles are to be found in all the vomit and dejections, as well as in the canal; sometimes single, sometimes two, three, four or more, joined end to end, as links of a chain; and these chainlets sometimes branching; that such forms are held together in mucous floccules, and come best to light when liquor potassæ is used; that within the small intestine they are often so numerous that not the smallest specimen will fail to show numbers of roundish fungic forms amid the débris of epithelium. He appends an illustration which shows quite unquestionably the forms of cryptogamic growth, and refers, for similar forms, to Schwann's then recently published investigations of yeast.

From 1838 till 1866 cryptogamic forms like these seem almost never to have been particularly observed. It is doubtful whether in 1849 they formed an undistinguished part of the miscellaneous phenomena at Bristol: but Mr. Marshall † and Mr. Berkeley ‡ seem, without attaching the least importance to the fact, sometimes to have seen them. A passing allusion to such forms, as of no particular importance, was made in relation to the Berlin epidemic of 1848 by Drs. Reinhardt and Leubuscher,§ as afterwards in relation to the Bavarian epidemic of 1854, by Dr. Buhl.‖ In 1854 in London Dr. Hassall, after examining for the then General Board of Health "about 25" specimens of rice-water discharge, stated very definitely that "in none of the samples were sporules or threads of any species of fungus present.¶

will probably find that, for that purpose, some plates which were published in the London Journal of Medicine, 1849, from etchings by Dr. Swayne, are better (as being more finely executed) than the woodcuts of the weekly journals of the time.

* Die kranke Schleimhaut in der asiatischen Cholera: Berlin, 1838.

† *See* Report of Drs. Baly and Gull, p. 18, and Mr. Marshall's letter appended to it, particularly at page 27.

‡ In paper, above referred to, in Med. Gaz. 1849.

§ In Virchow u. Reinh. Archiv, vol. 2, p. 414.

‖ In Hauptbericht über die Cho.-Epid. d. Jahres 1854, pp. 504–6.

¶ Appendix to Report of Committee for Scientific Inquiries, pp. 289–90.

An interesting reference in the present point of view is to the writings of Professor Pacini of Florence; for this accomplished observer, on various occasions from 1854 to the present time, has described the choleraic process as consisting primarily in a destruction of the epithelium and villi of the intestines by an infiltrative vibrional development, and has argued that these vibriones and their germs—molecules of less than $\frac{1}{25000}$ of an inch in diameter, poured forth in millions in the discharges of the sick, must constitute the contagium of cholera.* It seems possible that the difference between the *molecule vibrionali* of Pacini and the respecive micrococci and spores of Hallier, Klob and Thomé, may really be only a difference of name. Not only Pacini, but many other observers whose microscopical examinations have been carefully conducted, have also mentioned with more or less stress the abundance of what they have called "vibriones" in the choleraic discharges. For instance Dr. Hassall, after making the statement which I have just quoted as to the forms commonly recognised as fungic, adds: "Myriads of vibriones were detected in every drop of every sample of rice-water discharge hitherto subjected to examination. Of these vibriones many formed threads more or less twisted, while others were aggregated into masses which under the microscope presented a dotted appearance." I may remark, too, that the microscopical observations made in England during 1866, though they have not reinstated any of the fungi of 1849, or brought to light any figures resembling the spore-cysts of Hallier, are not without interest in relation to the questions here under discussion. Thus, I would particularly refer to the few remarks made by Dr. Sanderson and Dr. Bristowe respectively (supra, pp. 454–6) on the abundance of microscopical life which they found in the choleraic secretions of infected lower animals. And in the same point of view I would refer to Dr. Beale's papers in the *Med. Times and Gazette*, especially to that of August 18th, as representing, though with different nomenclature and different interpretation, much such an invasion of bowel-epithelium by low organic forms as that which the German observers insist upon.†

APPENDIX.

No. 11.
Professor Hallier on Cholera Fungus.

Note by Medical Officer.

Though I have thought it desirable for the scientific purposes of my report to advert very particularly to such statements as those which are mentioned in this portion of my appendix, I do not now venture to submit anything like a judgment on the very difficult eventual question which they seem to open. It appears to me that, before this can be done, not only the mere *biorama* (if I may so call it) of the intestinal contents, healthy as well as choleraic, will have to be studied far more extensively than it has yet been, and in all its accidental variations, but also that, in the general study of zymoses, no doubt must remain as to the ætiological significance of the low organic forms which attend the chemical transformation. It strikes me as of the utmost importance, scientific and practical, that investigations should now be vigorously pressed in both of the directions adverted to. It may not be irrelevant to remark that, equally for eye and hand, and intellect, such are among the most difficult of studies; that they form a very special branch of work hitherto but little cultivated among medical practitioners in this country;

* See Betti's *Considerazioni sul Colera Asiatico in Toscana;* Florence, 1858; vol. 5, pp. 333–334. Also Pacini's separate works: *sulla causa specifica del Col. Asiat.*, Florence, 1865, and *della natura del Col. Asiat.*, Florence, 1866.

† It deserves notice that Drs. Beale, Bristowe, and Sanderson, whom I believe to be three of the most trustworthy of observers, all (like Drs. Klob and Thomé) insist upon the active movements of the organic forms which they respectively describe, while Hallier apparently says that the minutest forms in his mycogony show none but passive movements.

Appendix.
No. 11.
Professor Hallier on Cholera Fungus.
Note by Medical Officer.

and that the temptation to generalise as to them from some small field of observation is one which ought peculiarly to be resisted. The possibilities of error are numberless. Pacini quotes from Bloch a very graphic expression of the truth in calling this field of study the "infusorial chaos" of the intestines. *Omne ignotum pro fungo* is of course a view less likely to be accepted in the present state of mycology than it may have been some 20 years ago: but any unpractised observer, going to work over-confidently in that "chaos," can scarcely fail to be a finder of mares' nests.

Finally, as regards Hallier's interesting reference to Dr. Tytler's doctrine of the origin of cholera in India, I may state that Dr. Tytler's views were published by him in London in 1833 in a pamphlet of 60 pages (long since out of print) entitled *Facts establishing the Deleterious Properties of Rice as an Article of Food.* Dr. Tytler's statements at the time excited very considerable interest, and were much discussed in medical societies and elsewhere. A very ample account, both of his statements and of the discussions which arose on them, may be read in Vol. I. of the *Lancet* for 1833–4.—J. S.]

Tab. 1.

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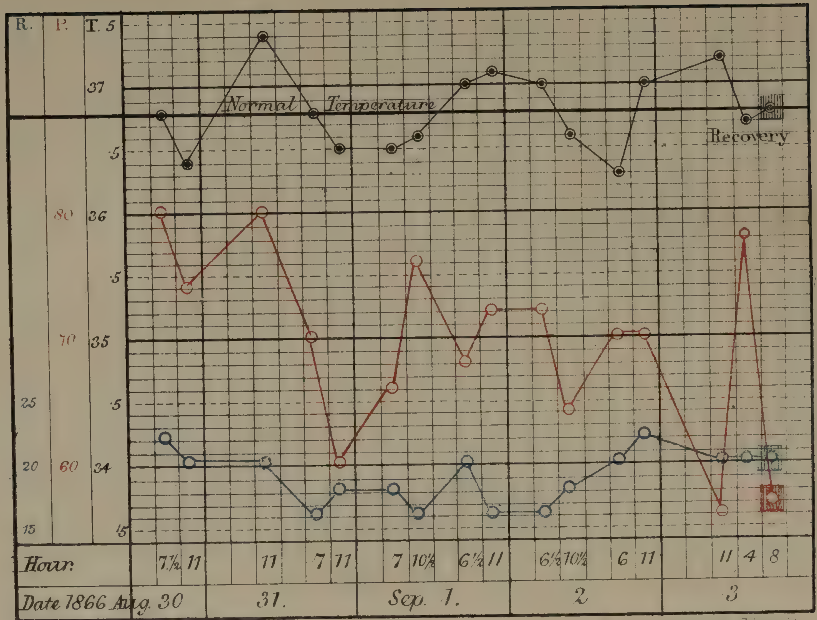

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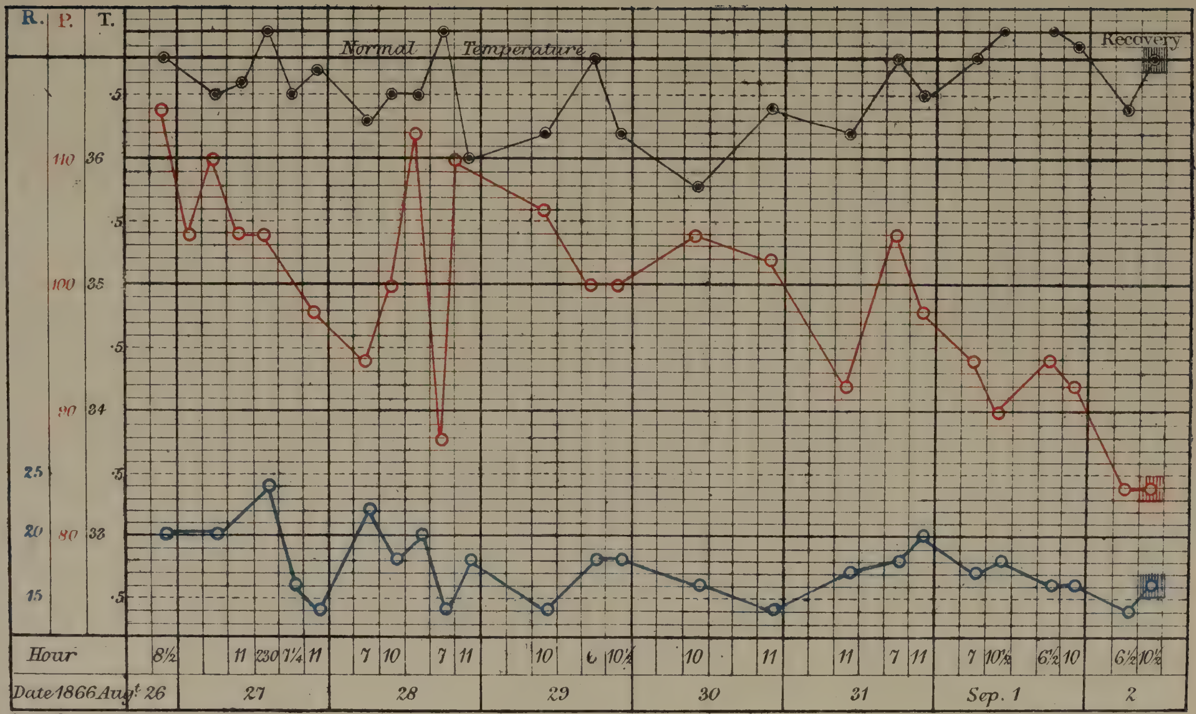

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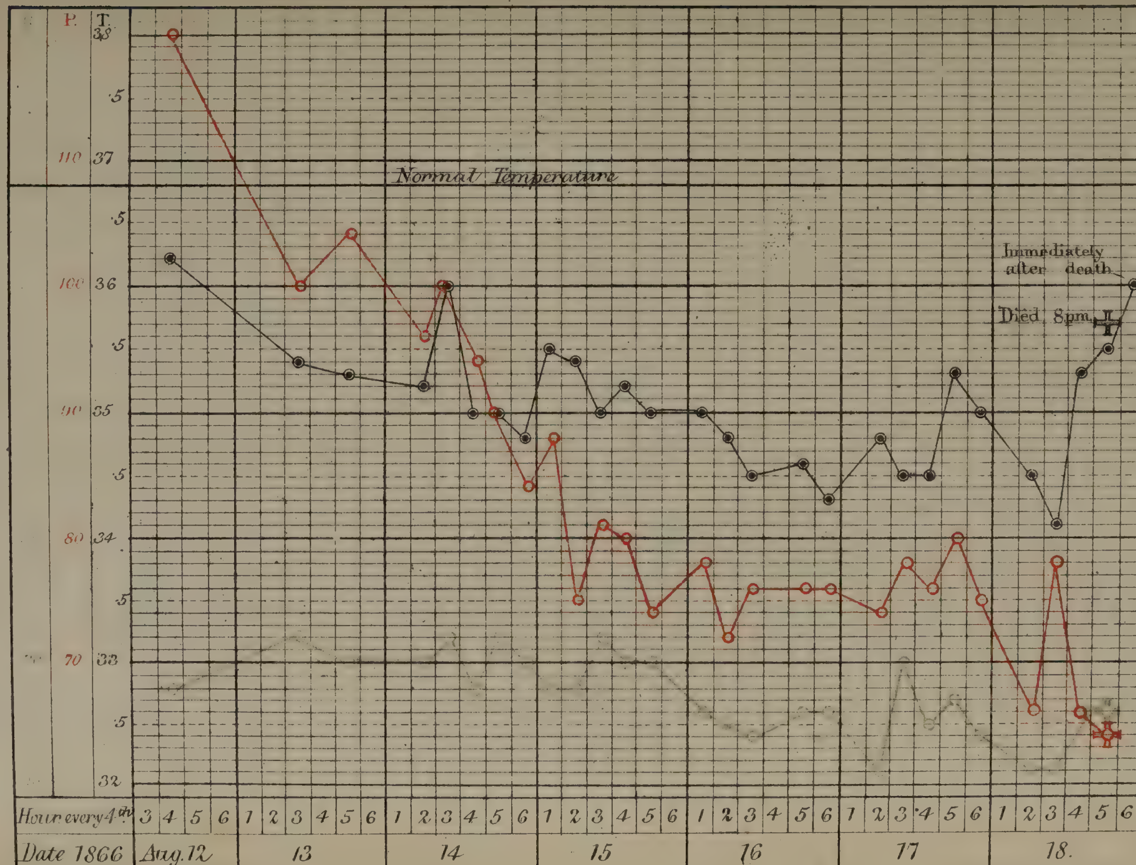

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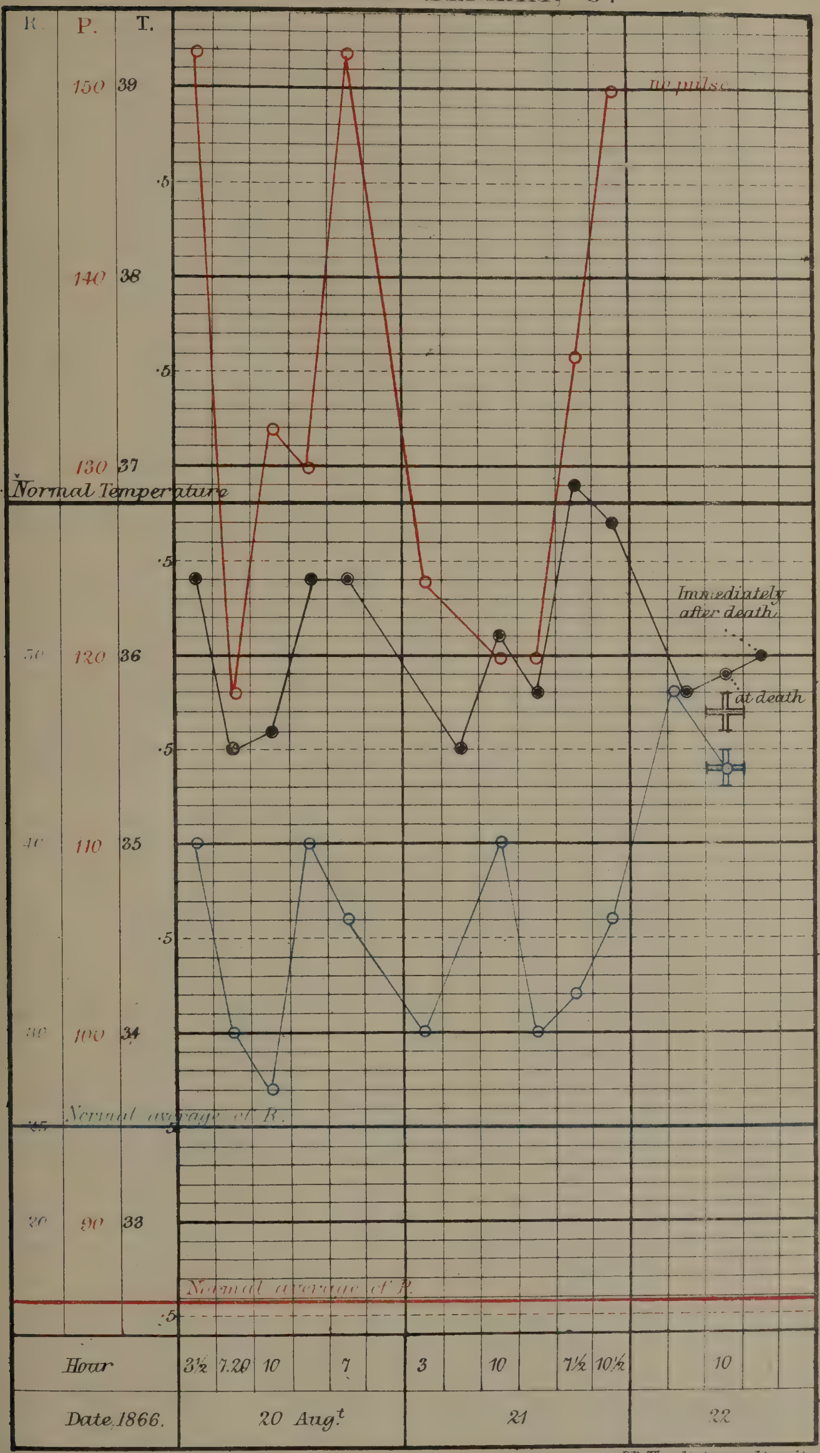

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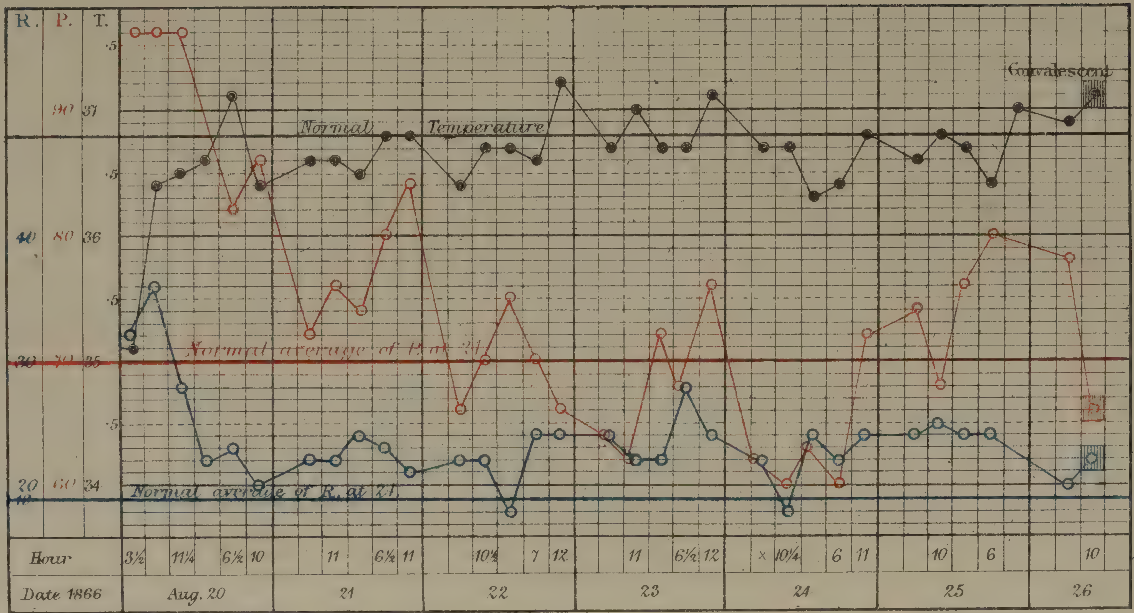

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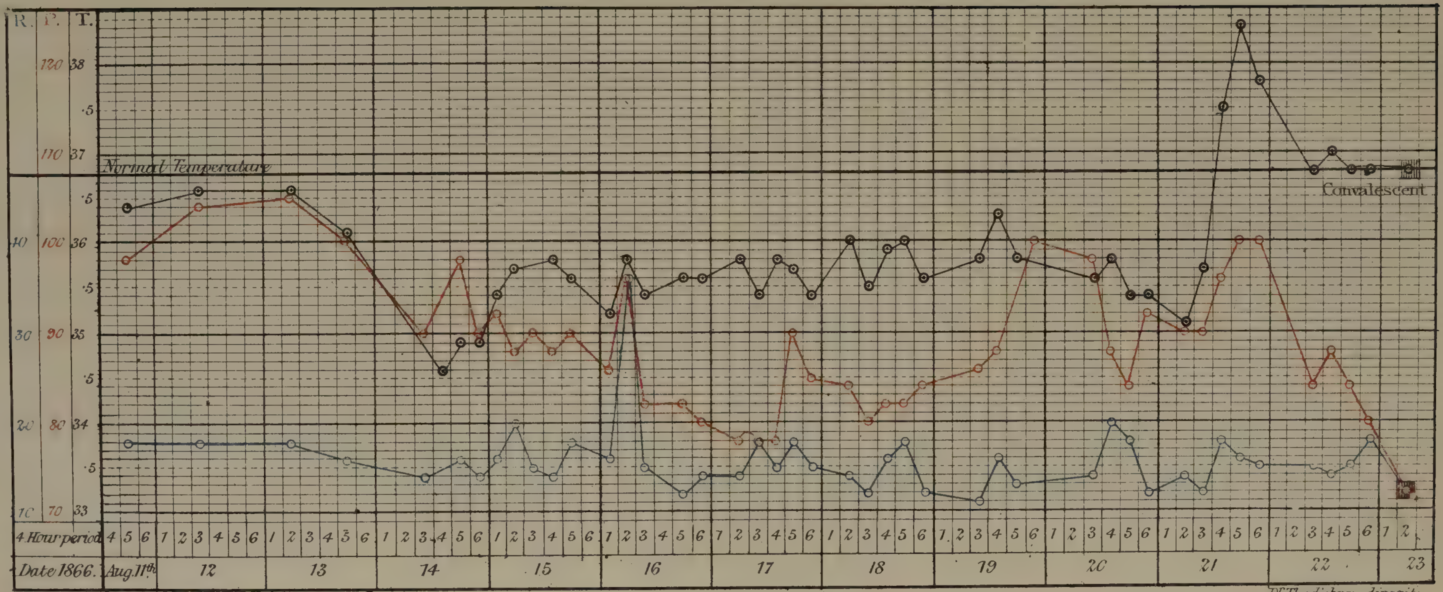

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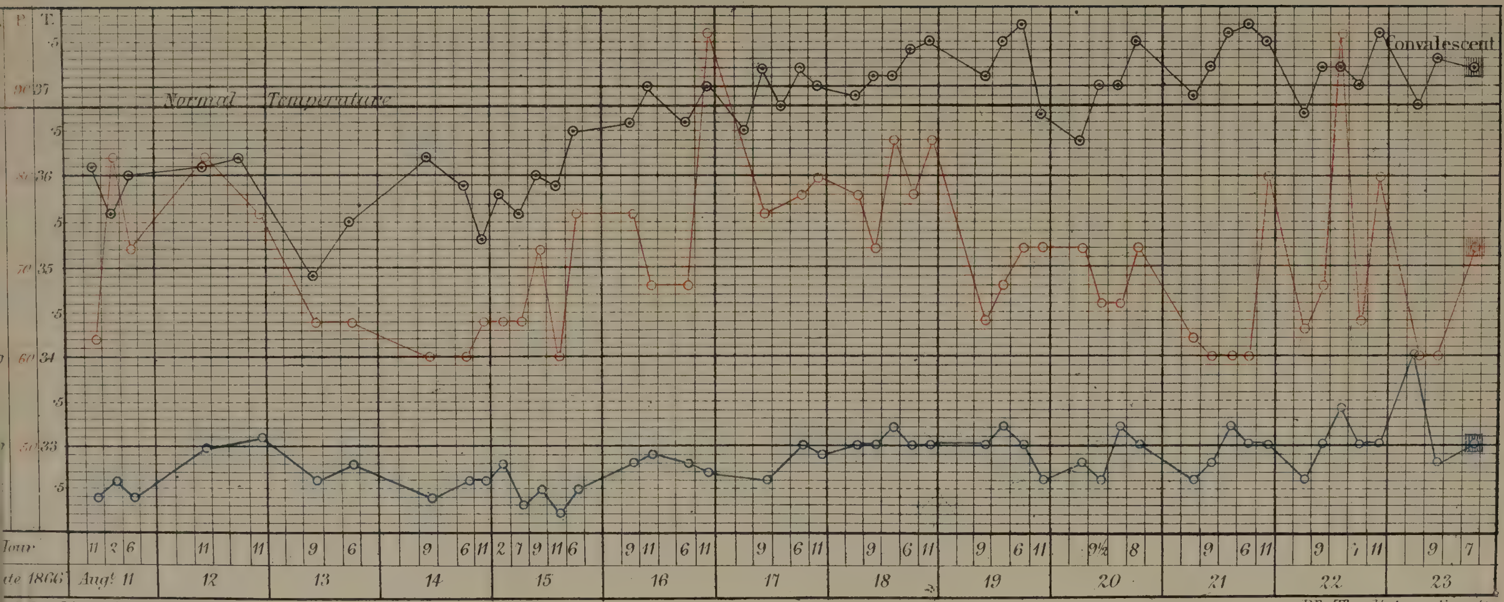

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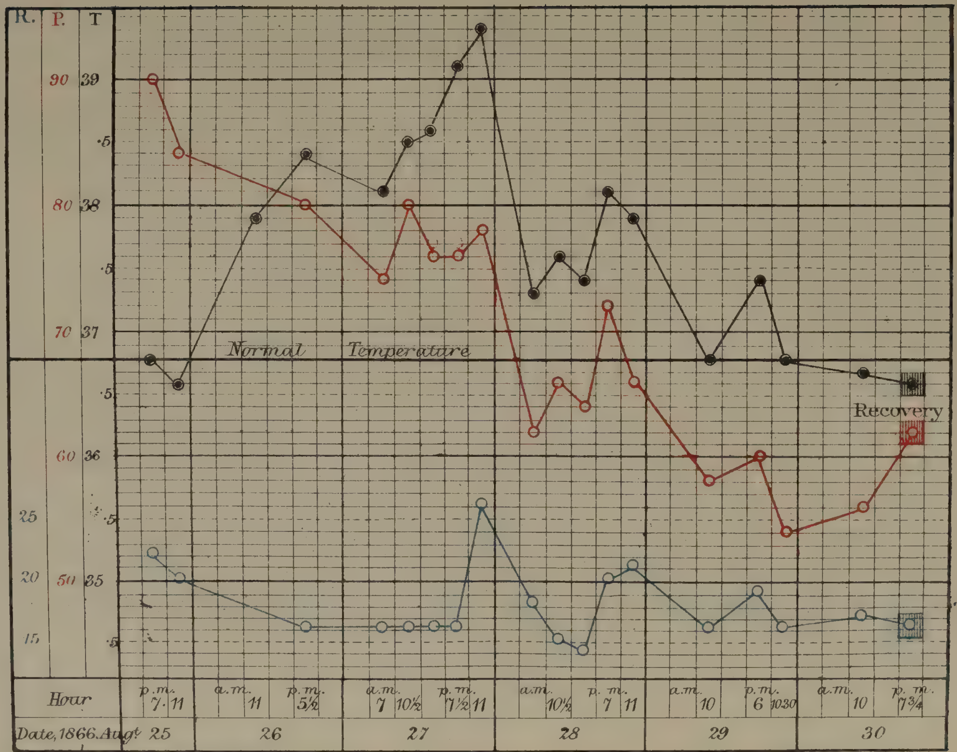

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Tab. 9.

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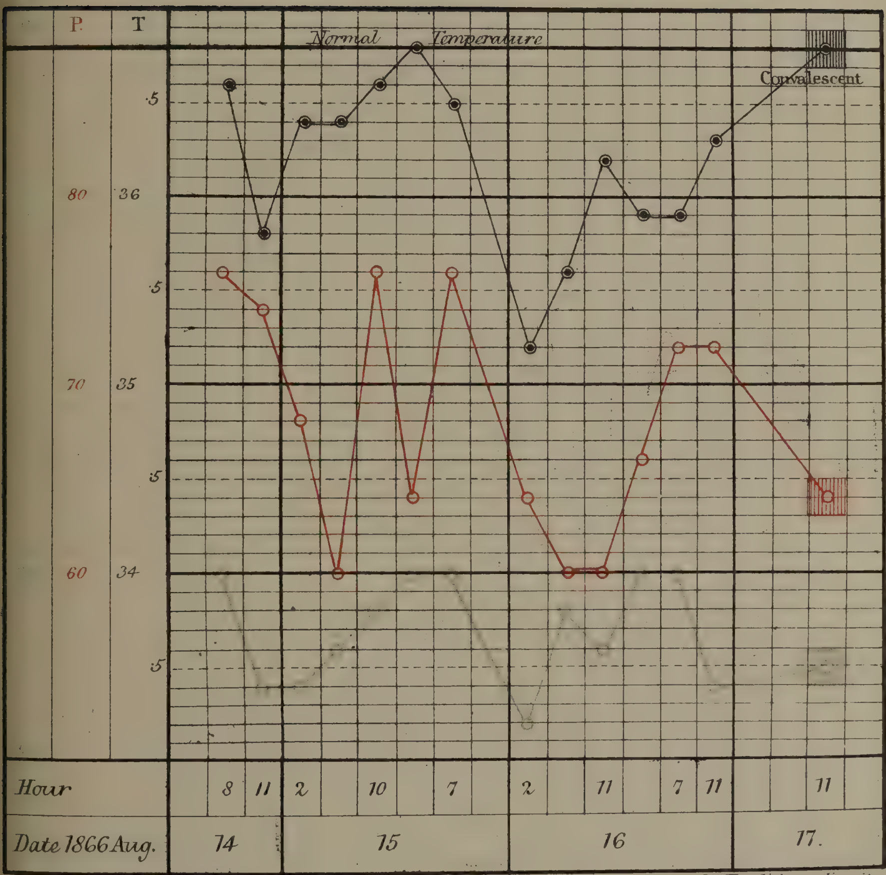

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Tab. 10.

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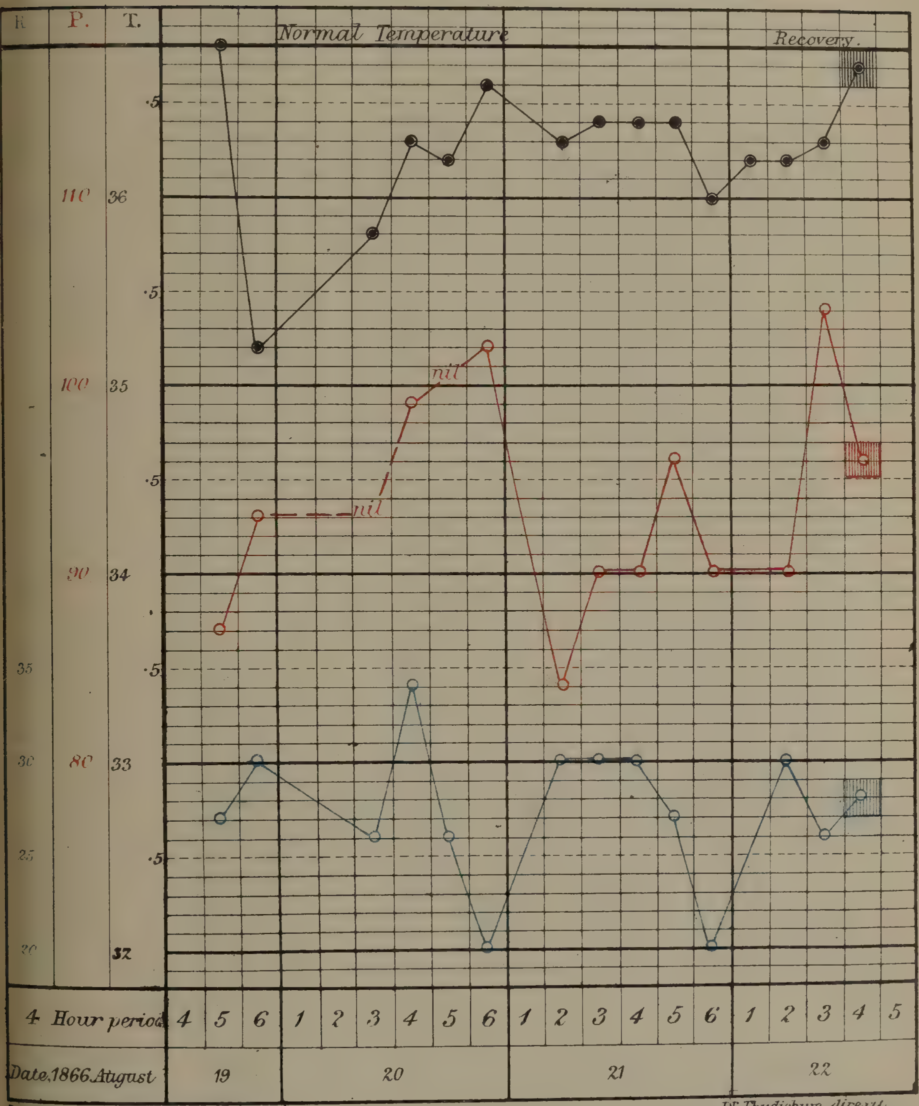

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Tab. 11.

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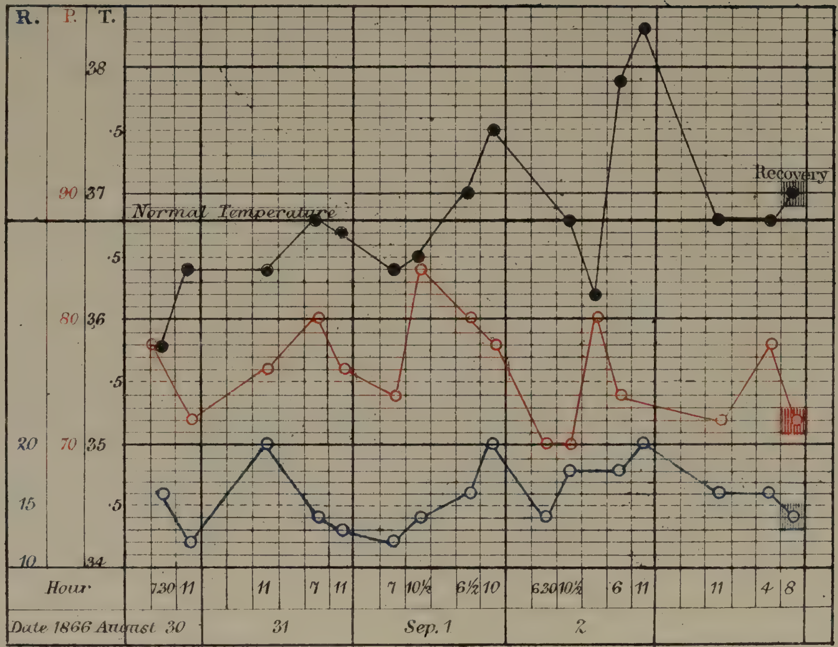

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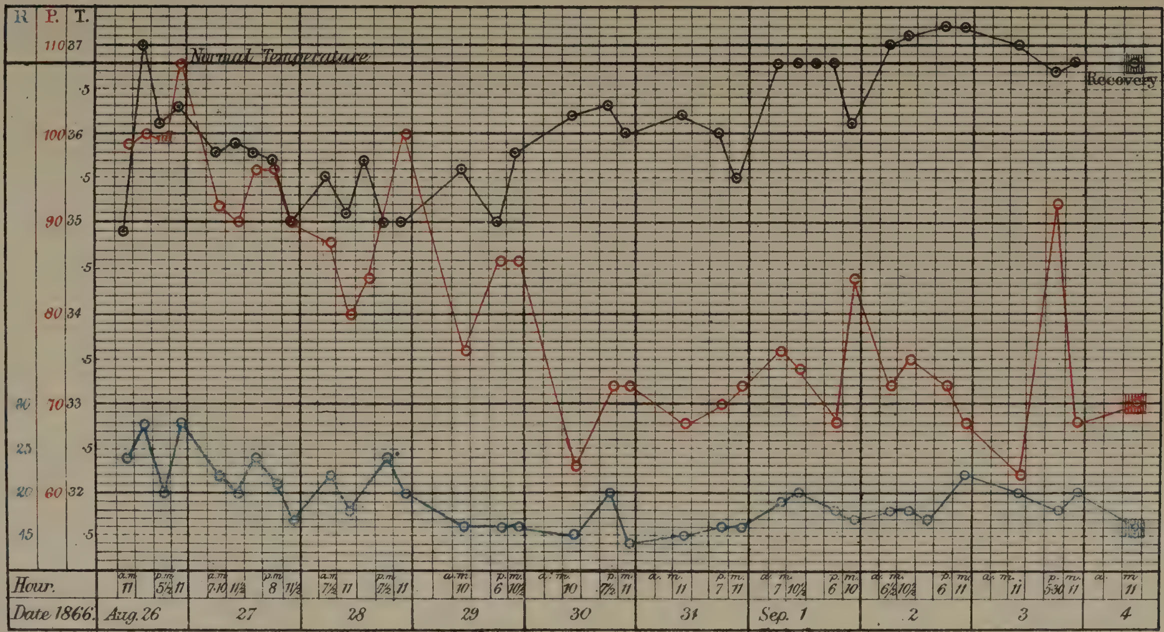

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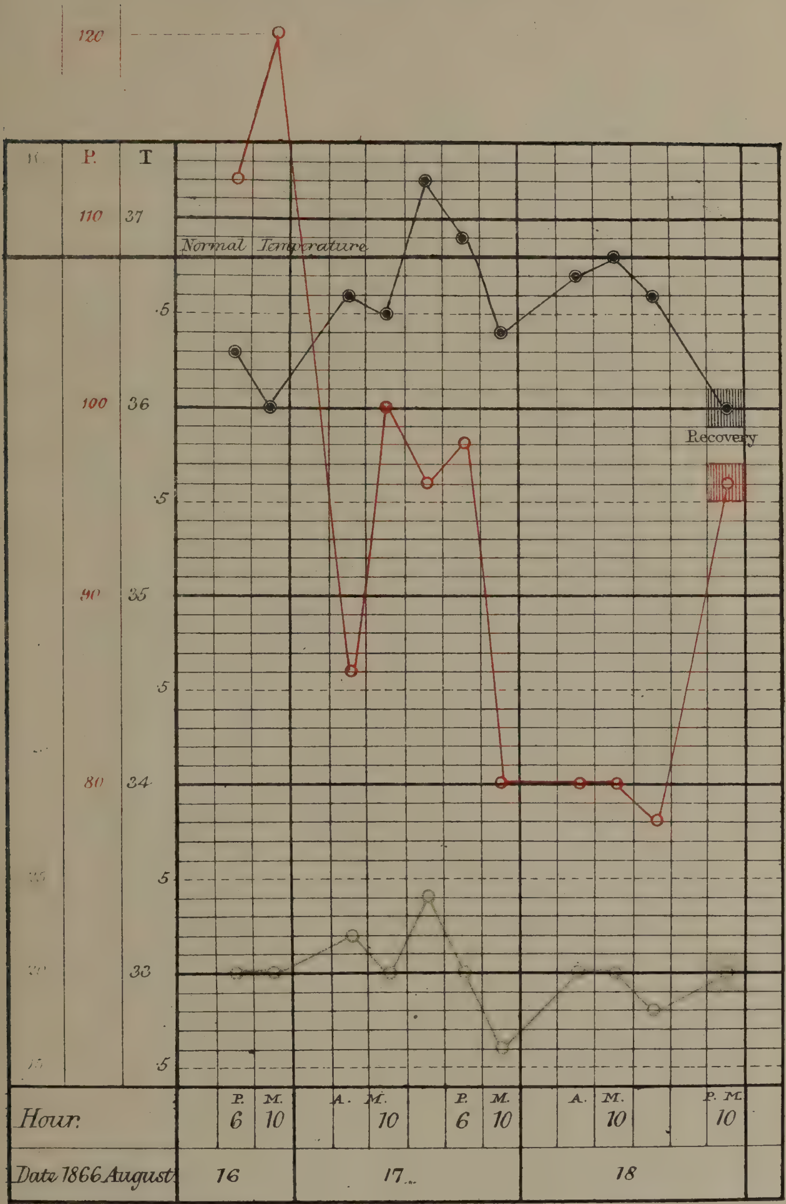

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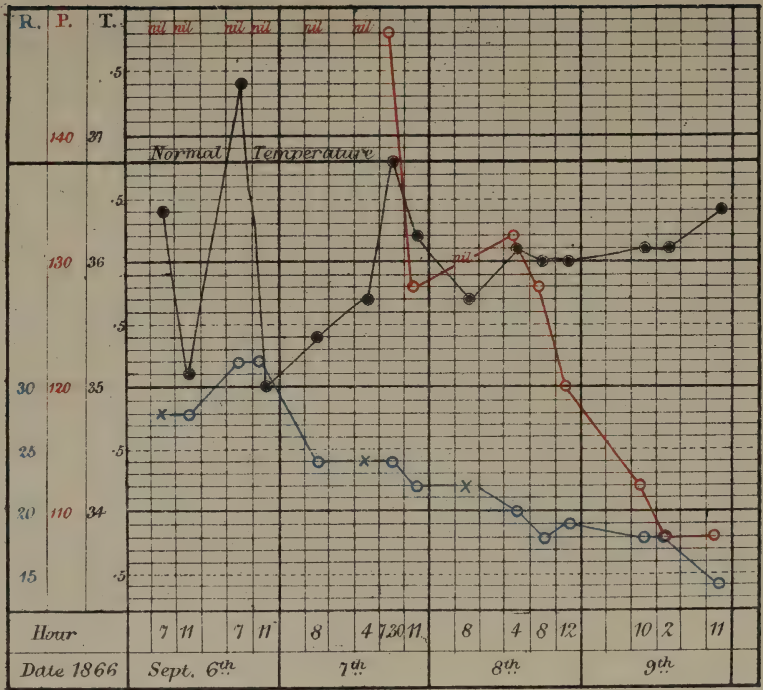

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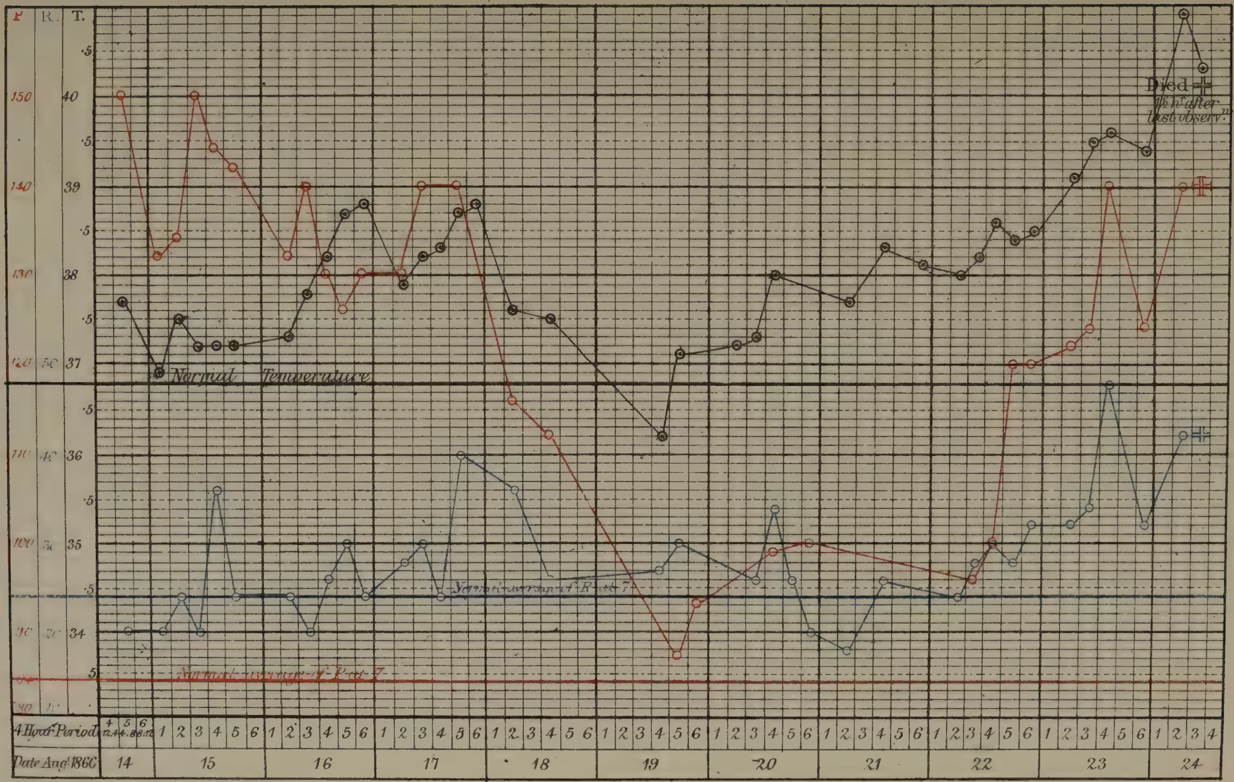

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DENNIS HEALEY, 25.

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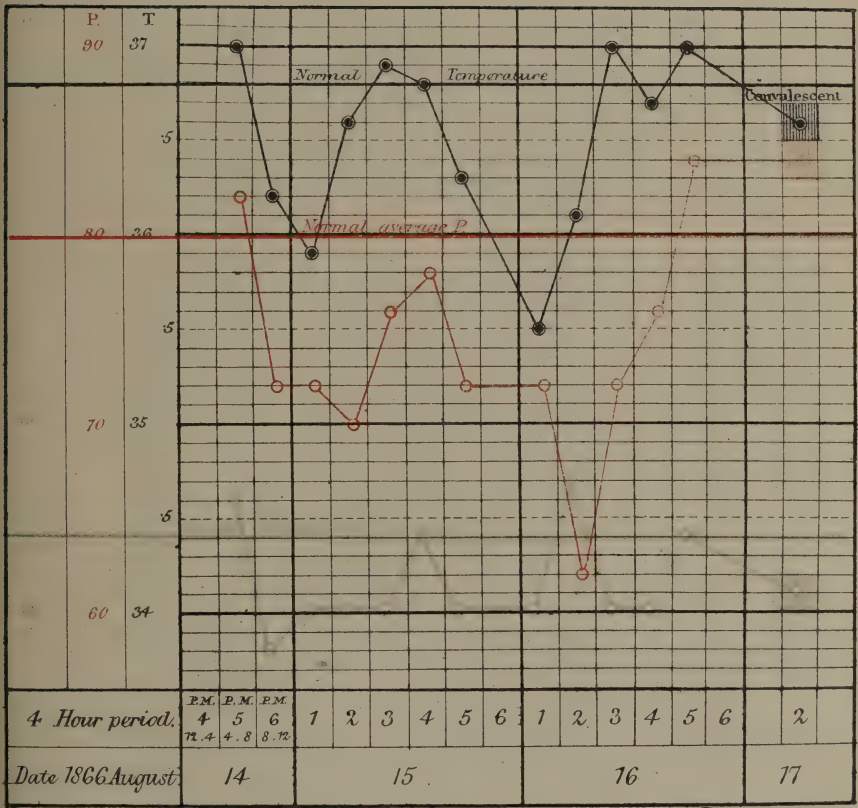

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Tab 18.

CHARLES JACKSON, 12.

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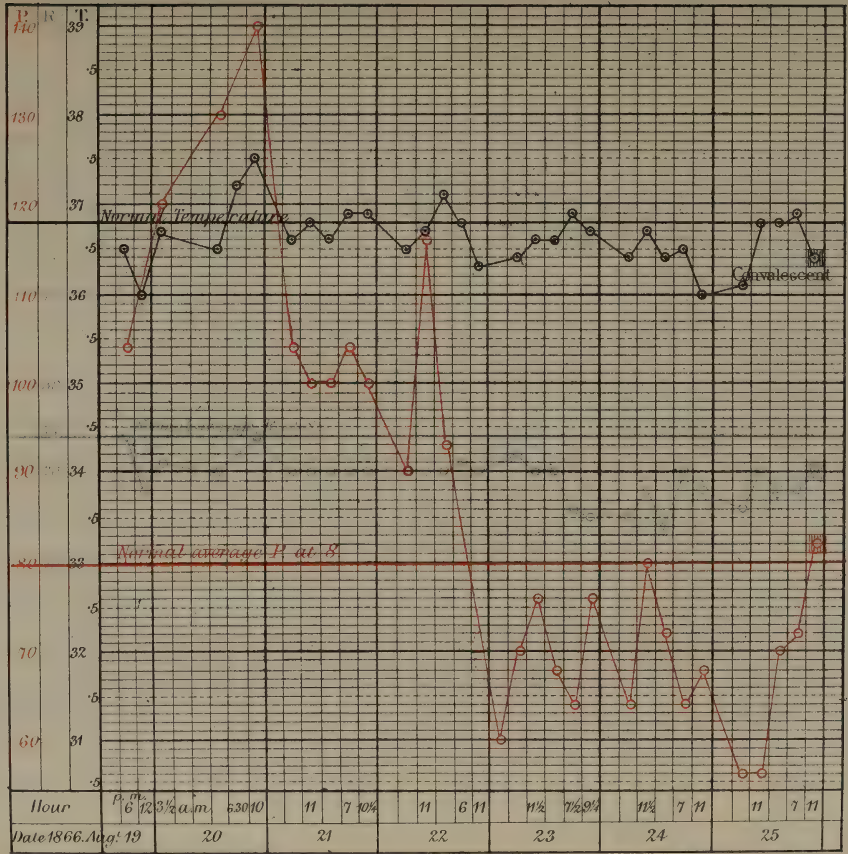
Tab. 19. JOSEPH JACKSON, 8.



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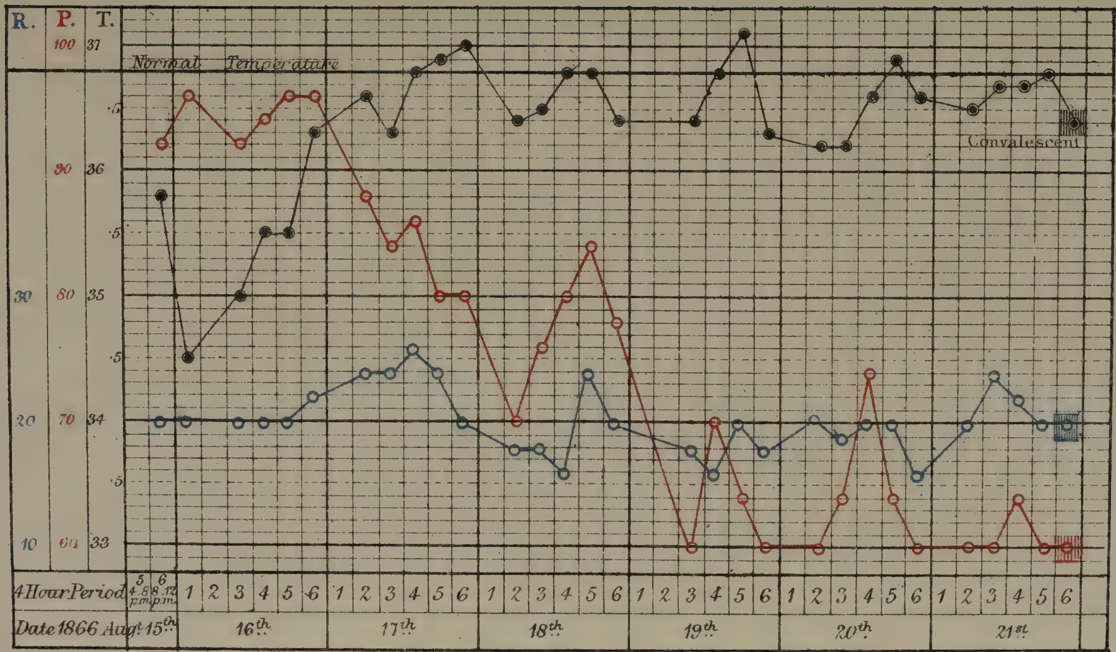
Tab. 20.

HENRY KING 48.



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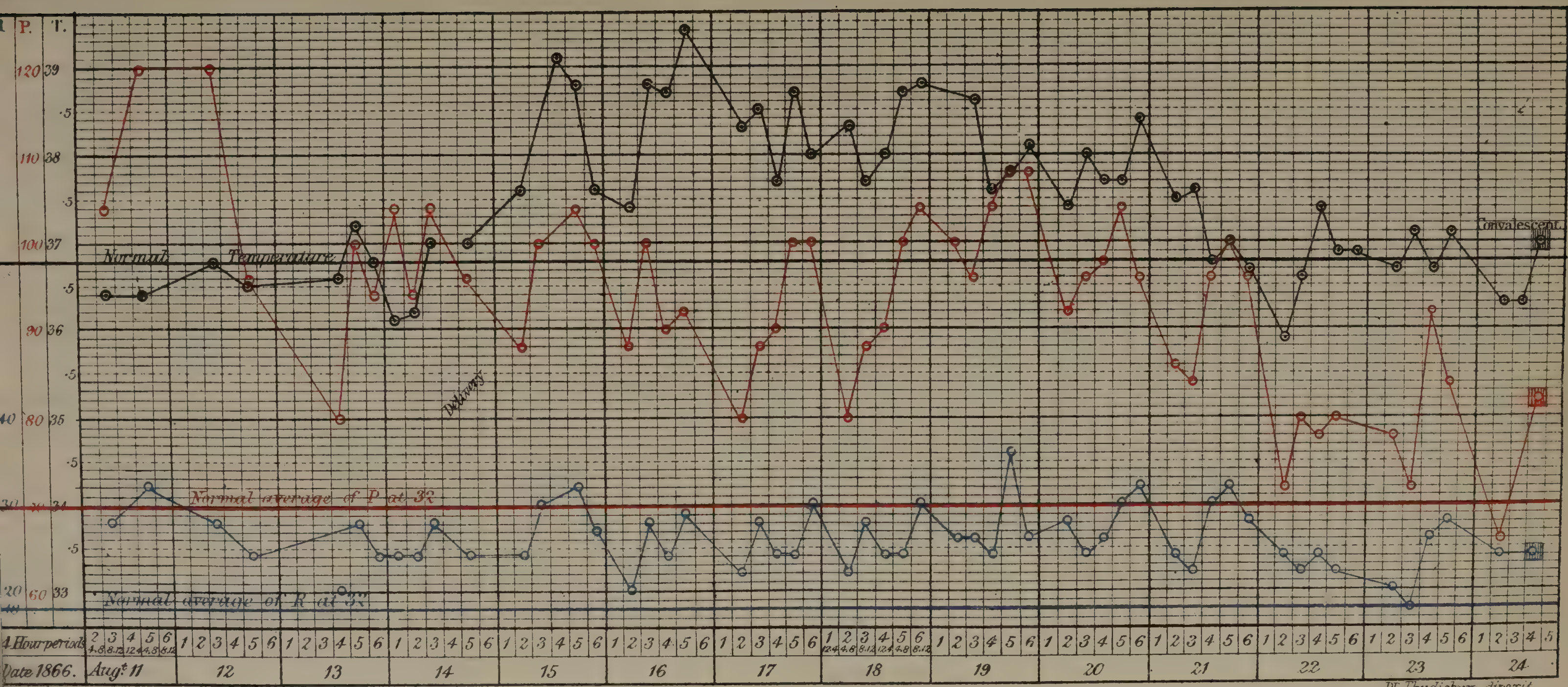
Tab. 21. CAROLINE KILBEY, 32.



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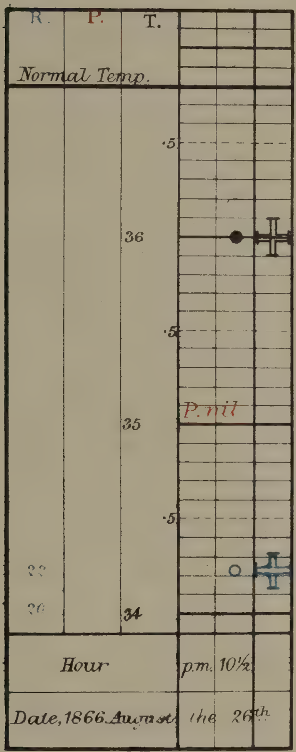
Tab. 22.

CHARLES LOMAS, 28.



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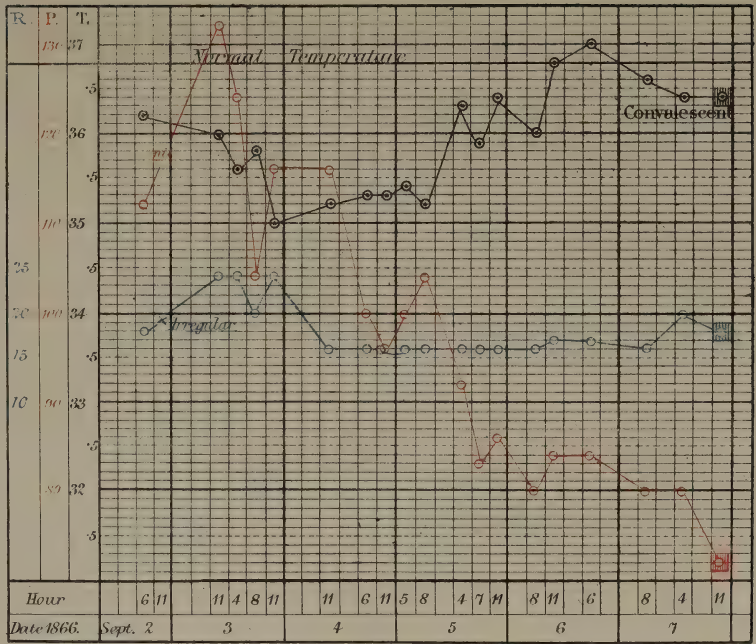
Tab. 23 JOHN MARTIN 15.



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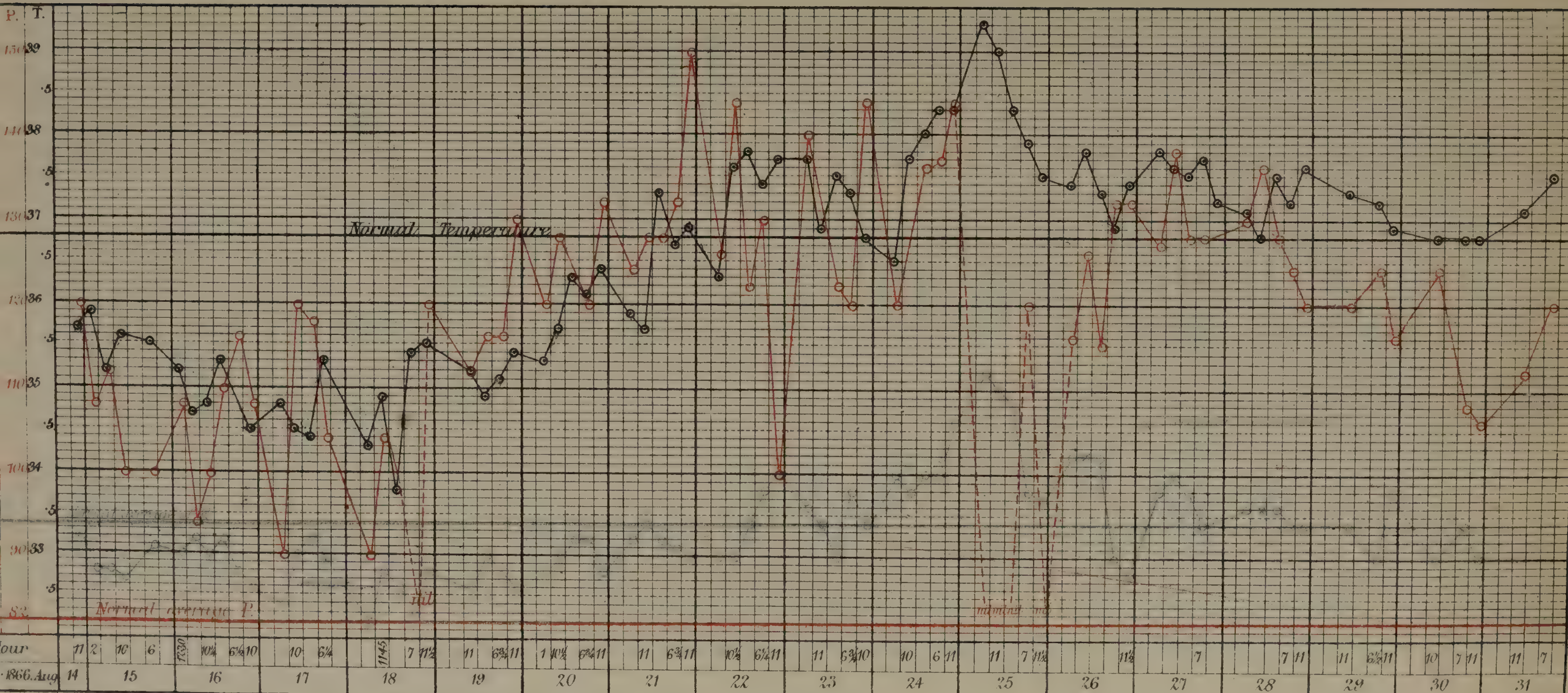
Tab. 24. CHARLOTTE MASON, 8.



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Tab. 25. EDWARD NASH, 8.

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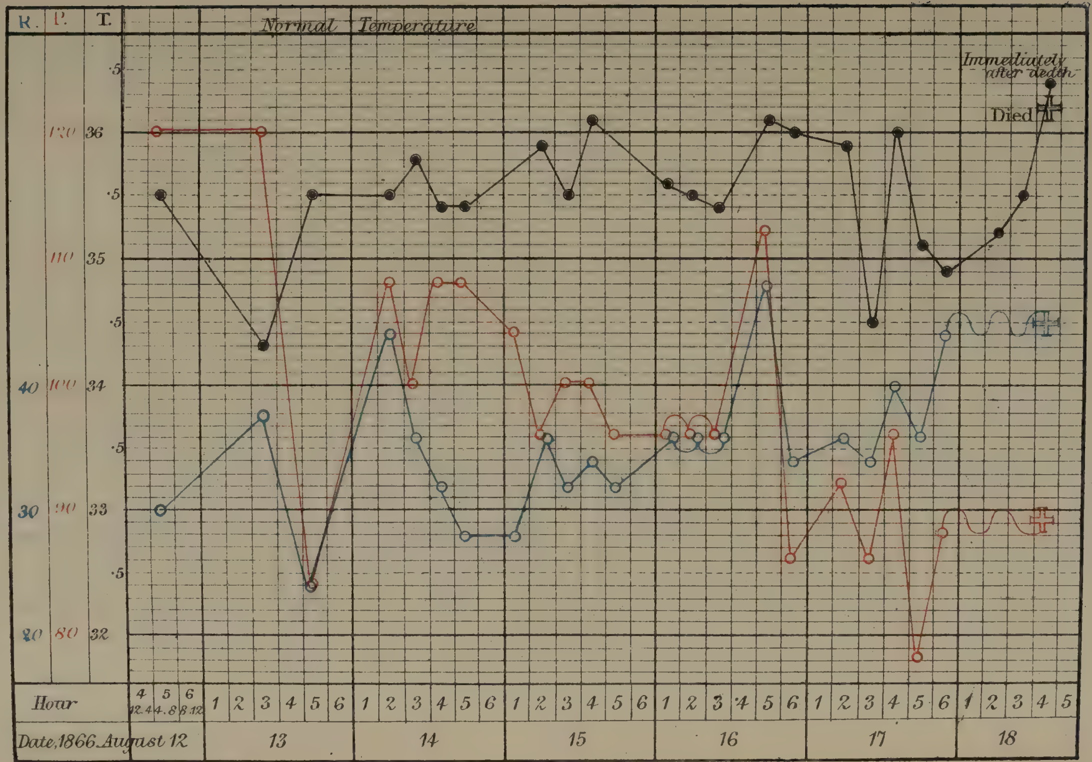
Tab 26

OLYFES NELSON 33.



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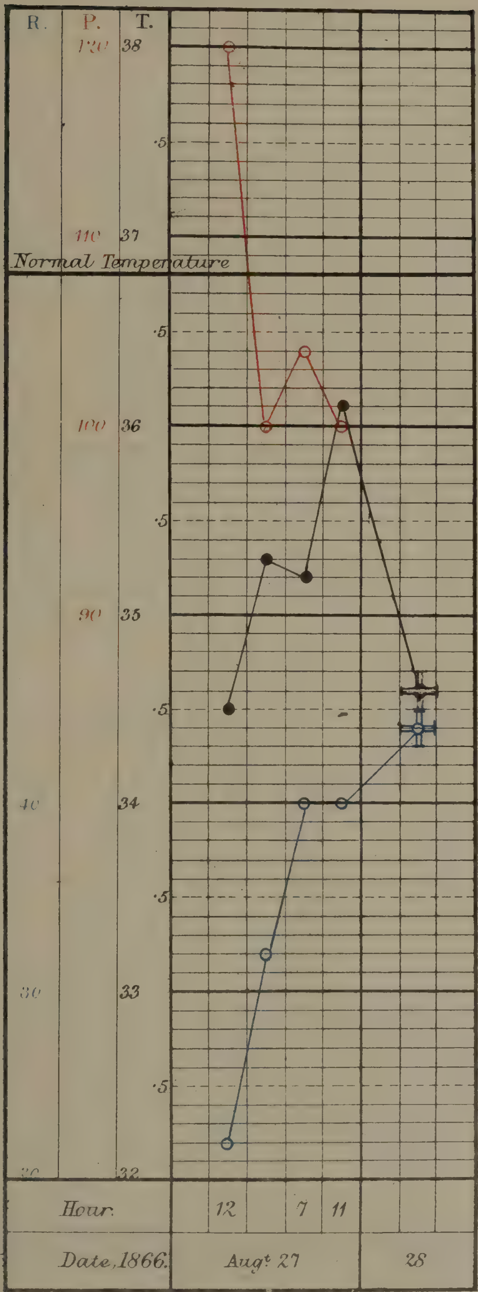
Tab. 27.

M. A. REED, 70.



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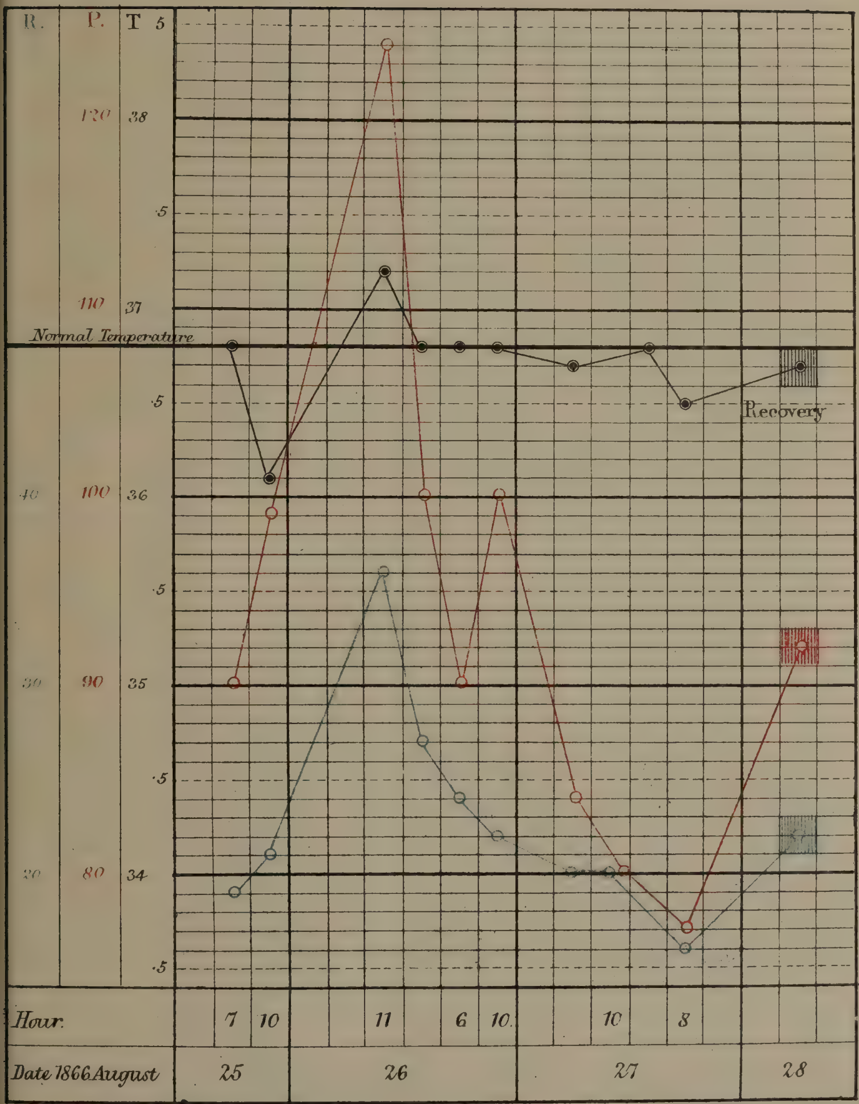
Tab. 28.

NAPOLEON REED, 22.



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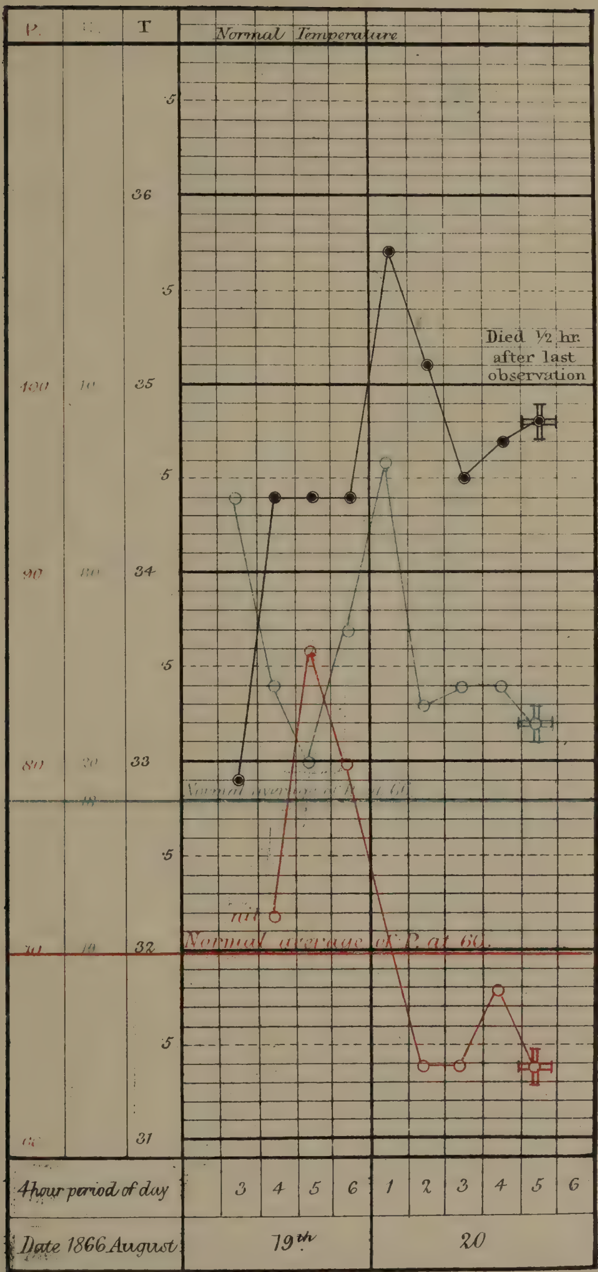
JOHN RIBOCQ 66.



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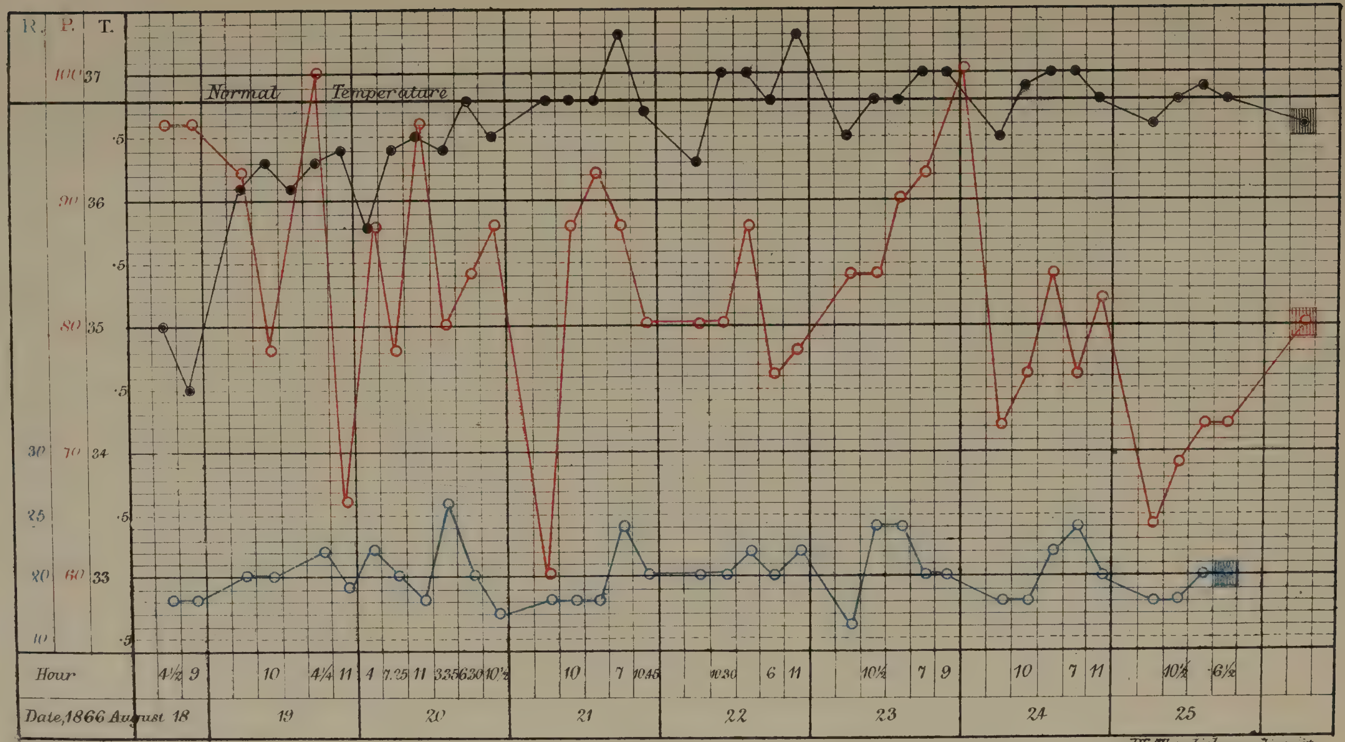
Tab 30.

ANN ROSEDALE, 44.



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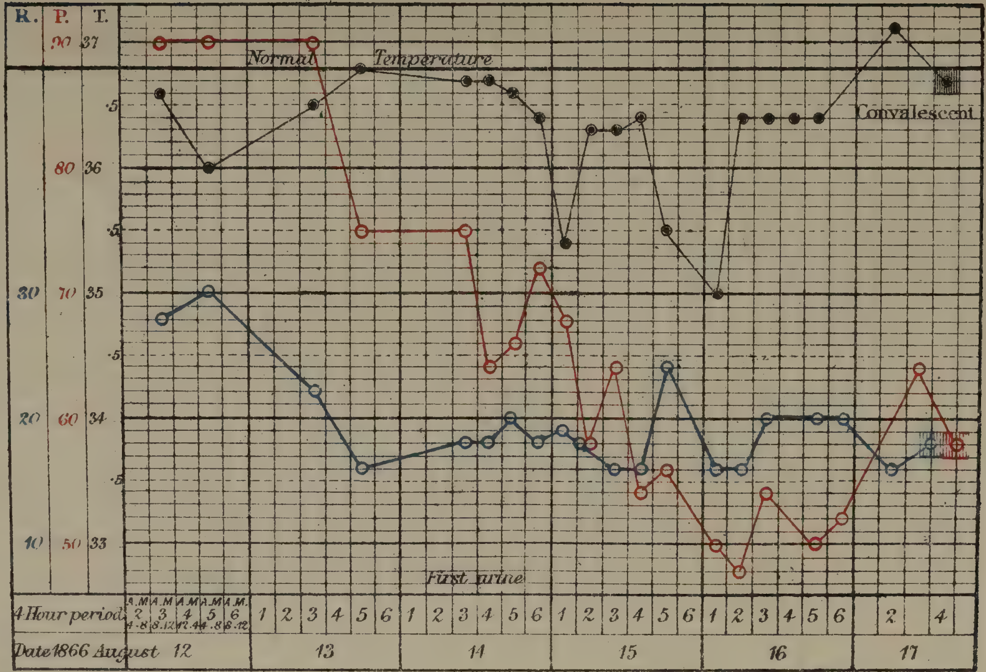
Tab. 31.

BERNHARD SCHEINER 25.



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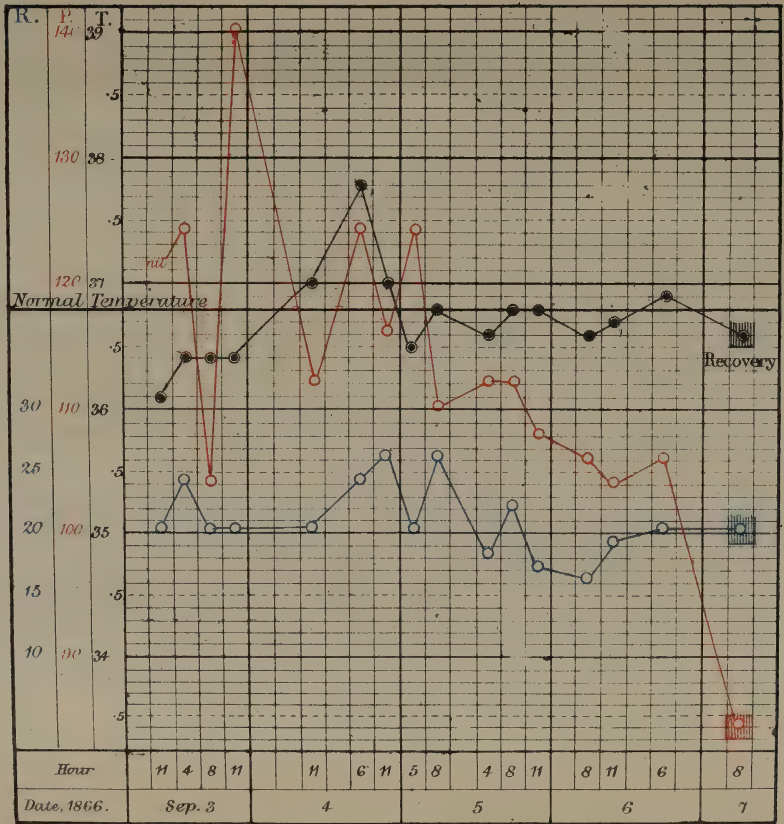
JOSEPH SHIELS, 11.



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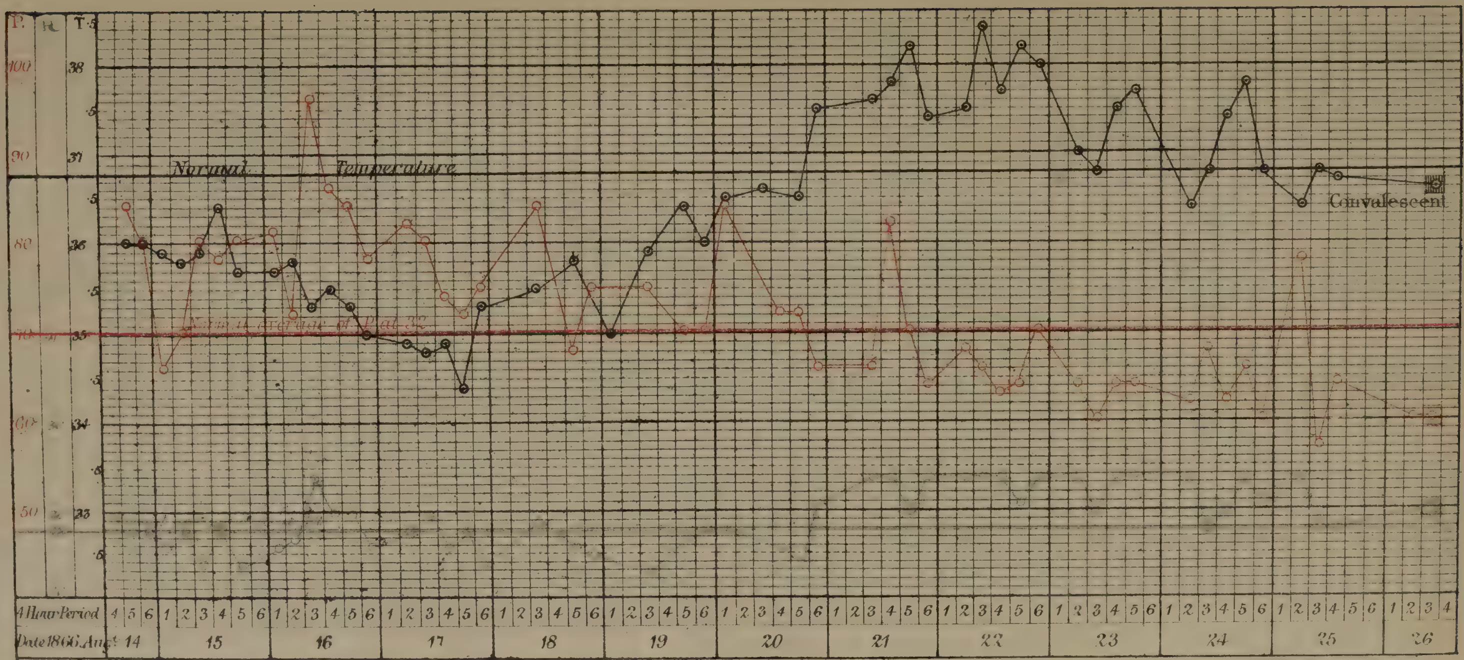
Tab. 33. EMMA SMITH, 32.



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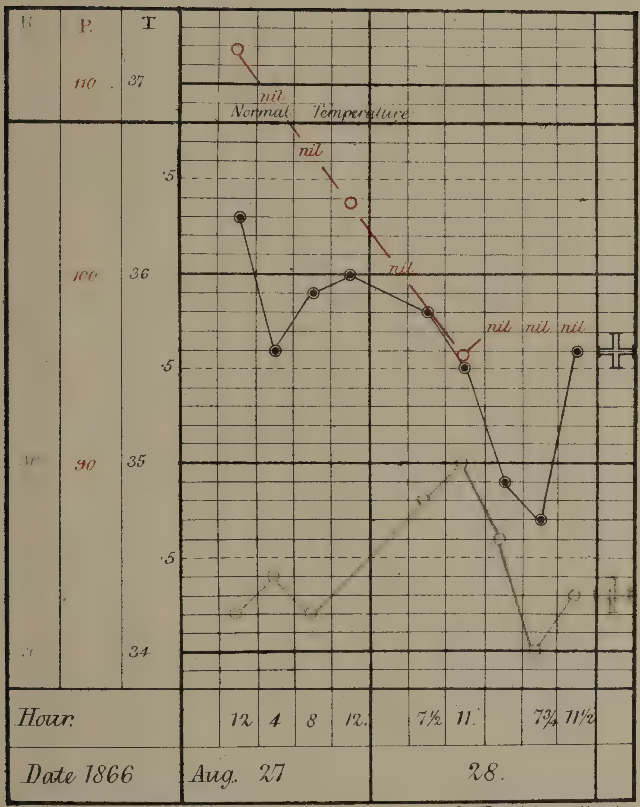
Tab. 34.

MARGARET SPEARS, 40.



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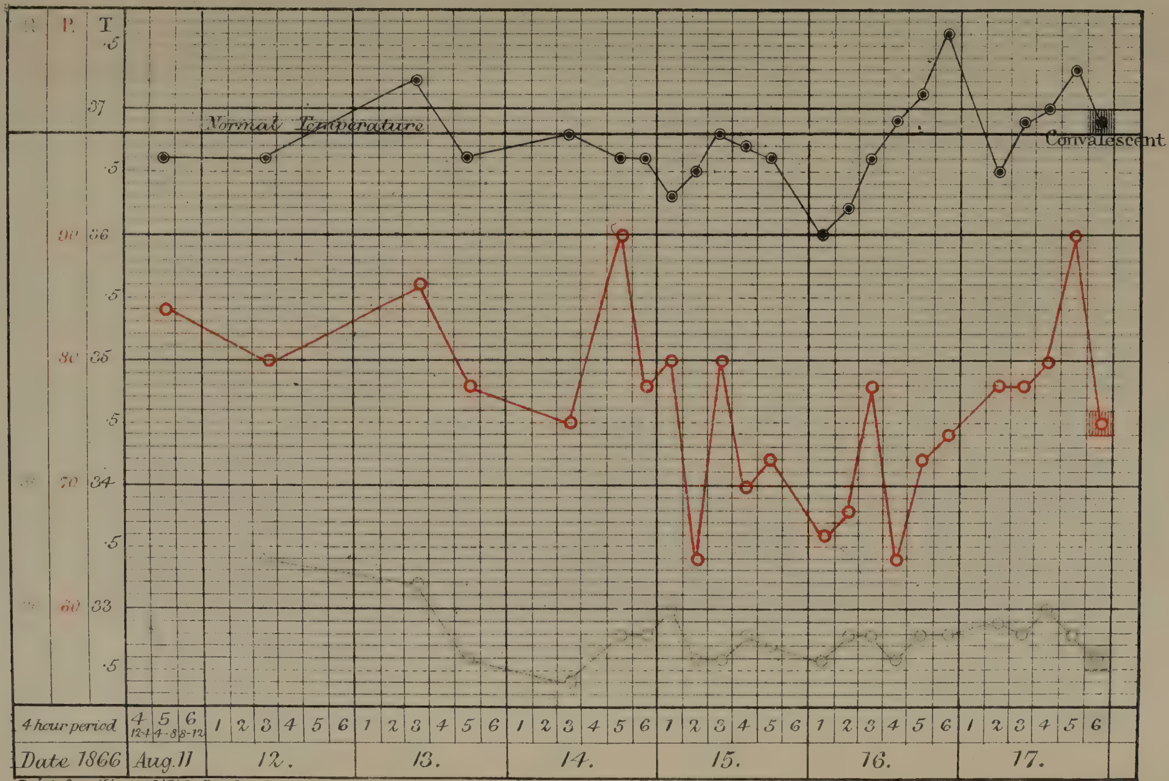
Tab. 35.

HENRY TAYLOR.



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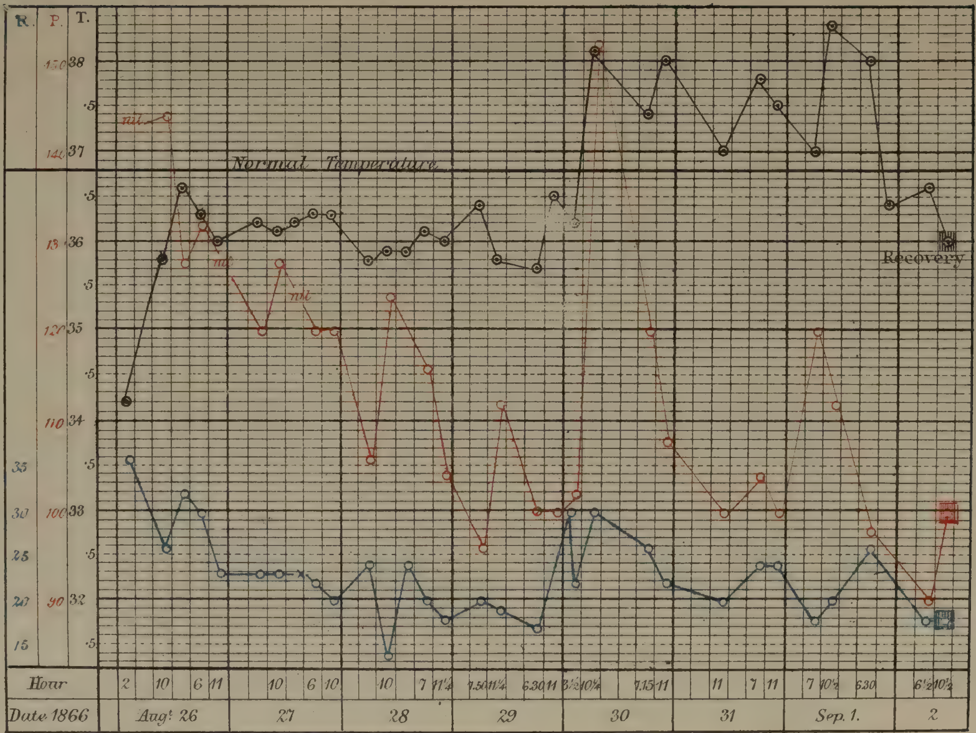
Tab. 36. MARY ANNE TONZEL, 11.



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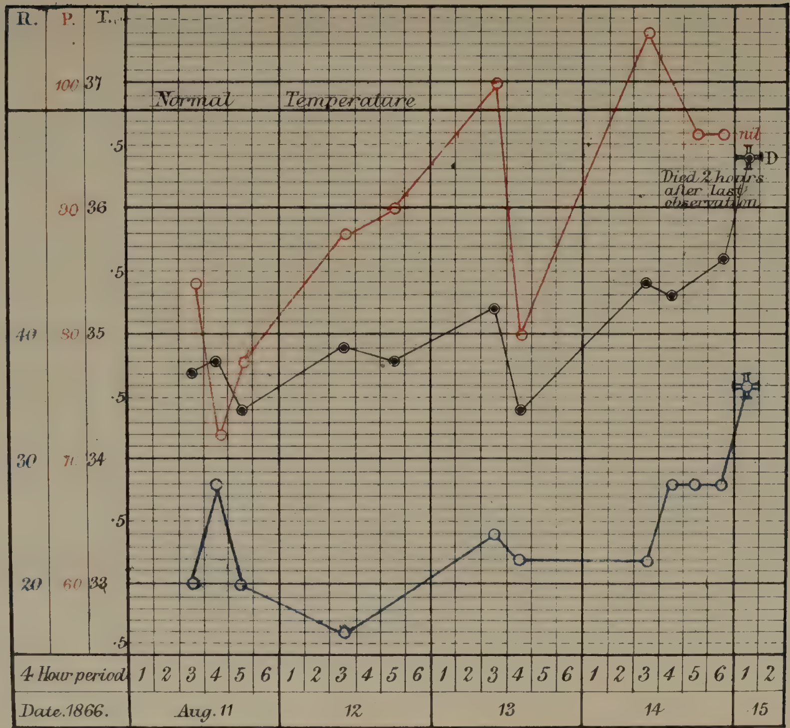
Tab. 37.

JANE TURNBULL, 44



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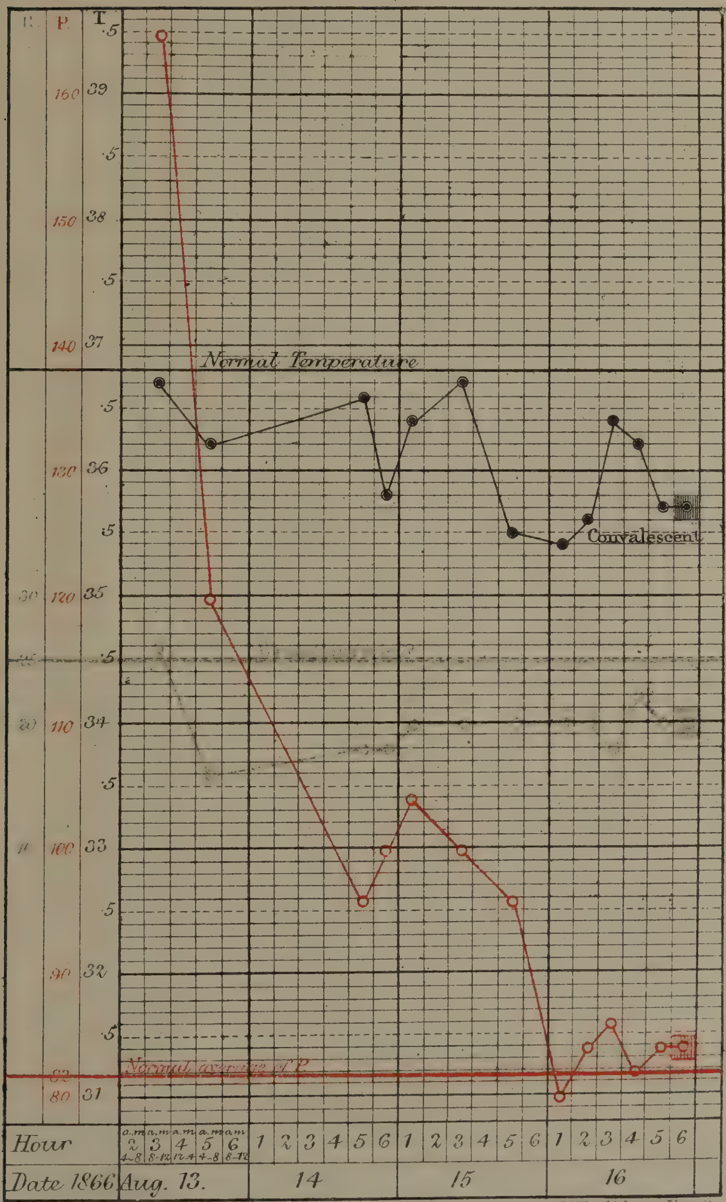
Tab. 38.

CELIA TURNER, 8.



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Tab. 39.

JANE VOWLES, 2.

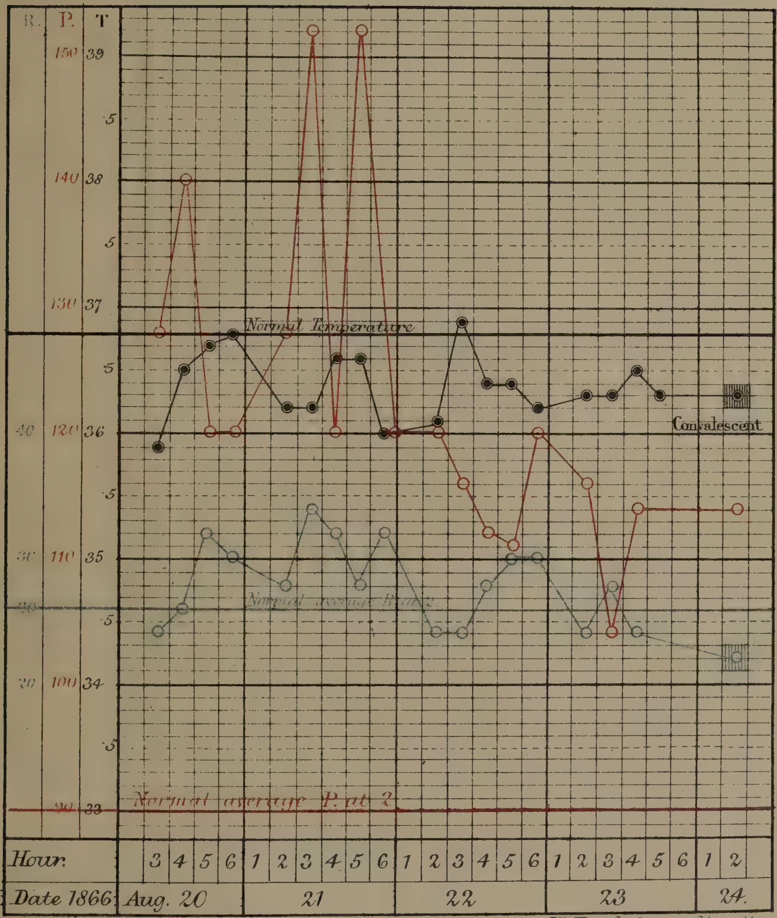

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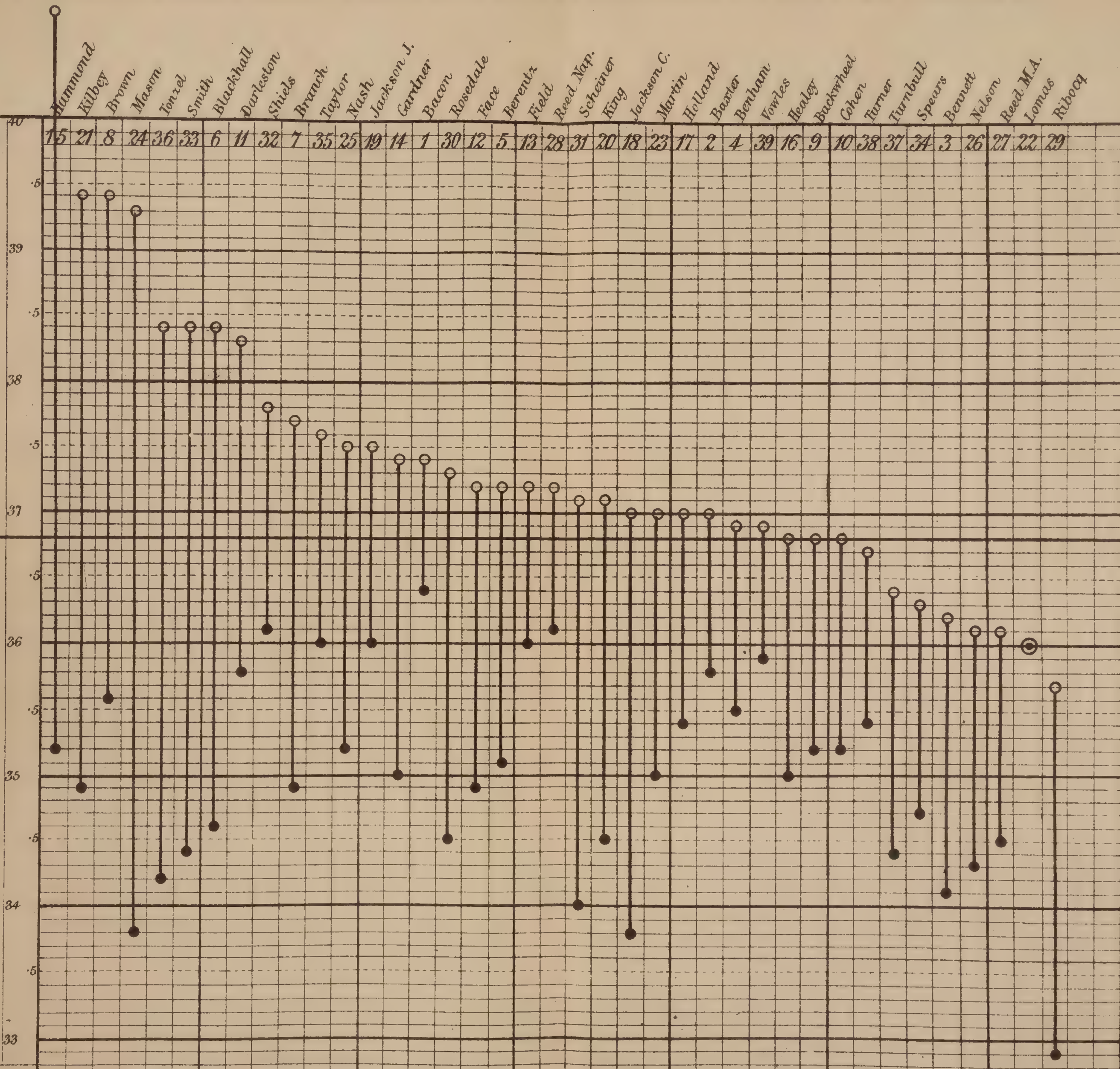
Table 40.

MAXIMA (○) AND MINIMA (●) OF TEMPERATURE OBSERVED IN 39 CASES OF CHOLERA.



Name	Nº of Case and Table	Cases in Collapse	Cases in Reaction	Deaths	Duration of Illness, days	Nº of days T.P.R. observed	Sex, M male, F female	Age, years
(key)		C	R	†				
Hammond	15		R	†	16	11	M	7
Kilbey	21		R		16	14	F	32
Brown	8		R		10	6	M	28
Mason	24	C	R		18	18	F	8
Tonzel	36	C	R		9	8	F	11
Smith	33	C	R		16	13	F	32
Blackhall	6	C	R		13	13	M	29
Darleston	11		R		12	5	M	36
Shiels	32	C	R		6	5	M	11
Branch	7	C	R		15	13	M	29
Taylor	35		R		9	7	M	?
Nash	25	C	R		11	11	M	8
Jackson J.	19	c	R		13	7	M	8
Gardner	14	C	?	†	?	4	?	?
Bacon	1		R		11	5	M	34
Rosedale	30	C	R		10	9	F	44
Face	12	C	R		12	10	M	21
Berentz	5	C	R		14	7	M	24
Field	13	C	R		10	3	M	9
Reed Nap.	28	C	R		8	4	M	22
Scheiner	31	C	R		8	6	M	25
King	20	C	R		7	7	M	48
Jackson C.	18	C	R		7	7	M	12
Martin	23	C	R		6	6	M	15
Holland	17	c	R		5	4	F	9
Baxter	2		R		9	8	M	55
Benham	4	C	R	†	18	3	M	6
Vowles	39	C	R		8	5	F	2
Healey	16	C	R		7	7	M	25
Buckwheel	9	c	R		6	4	F	10
Cohen	10		R		8	4	F	2⅔
Farmer	38	C	R		5	4	F	8
Turnbull	37	C	R	†	13	5	F	44
Spears	34	C		†	3	2	F	40
Bennett	3	C	R	†	8	7	F	30
Nelson	26	C	R	†	8	7	M	33
Reed M.A.	27	C		†	3	2	F	70
Lomas	22	C		†	2	1	M	28
Riboeq	29	C		†	2	2	M	66

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To illustrate Mr Radcliffe's Report


MAP SHOWING THE DISTRIBUTION OF DEATHS FROM CHOLERA, IN THE REGISTRATION DISTRICTS OF LONDON. 1866.
The figures show the ratio of Mortality per 10,000 Population.
The shades of Color, passing from the lightest to the darkest, indicate the ratio of Mortality per 10,000 Population in the following gradation:- less than 5, 5 to 10, 10 to 15, 15 to 20, 20 to 25, 40 to 60, 60 to 80, 80 to 100, upwards of 100.
ISLINGTON 4·3
HACKNEY 10·6
LEYTON
ST PANCRAS 6·0
MARY-LE-BONE 3·0
CLERKENWELL
ST LUKE
SHOREDITCH
HOLBORN
ST GILES
EAST LONDON
WEST LONDON
LONDON CITY 5·0
ST JAMES WESTMINSTER
STRAND
Cholera Field 1854. 152·2
ST MARTIN IN THE FIELDS
WESTMINSTER
ST GEORGE HANOVER SQUARE
KENSINGTON
CHELSEA
ST SAVIOUR SOUTHWARK 7·4
ST OLAVE SOUTHWARK
ST GEORGE SOUTHWARK 6·6
NEWINGTON
BERMONDSEY
ROTHERHITHE
The Chief Cholera Field of 1849 & 1854.
1849. 147·2
1854. 114·8
CAMBERWELL 5·6
LAMBETH
WANDSWORTH
C
A
A
WEST HAM
STEPNEY (LIMEHOUSE
127·6
RIVER THAMES
RIVER LEA
GREENWICH (DISTRICT)
GREENWICH
WOOLWICH
CHARLTON AND PLUMSTEAD 6·6 6·6
LEWISHAM
Limits of the East London Water Company's supply:- Where continuous (▬) the line shows the district (B) supplied from the Lea Bridge Reservoirs.. Where broken (▬ ▬) the line shows the districts (A) supplied from the Old Ford Reservoirs. Where both dotted and broken (▬ ▬ ▬) the line indicates a locality which is partly supplied from Old Ford. Where the line is drawn by notes of interrogation (???) it indicates rural districts supplied to an uncertain and comparatively small extent from Old Ford.. The slighter marked continuous and broken lines (—— – –) indicate districts (C) supplied indifferently and to an undetermined extent from both the Lea Bridge and the Old Ford Reservoirs.

To Illustrate Mr. Radcliffe's report. No. 3.

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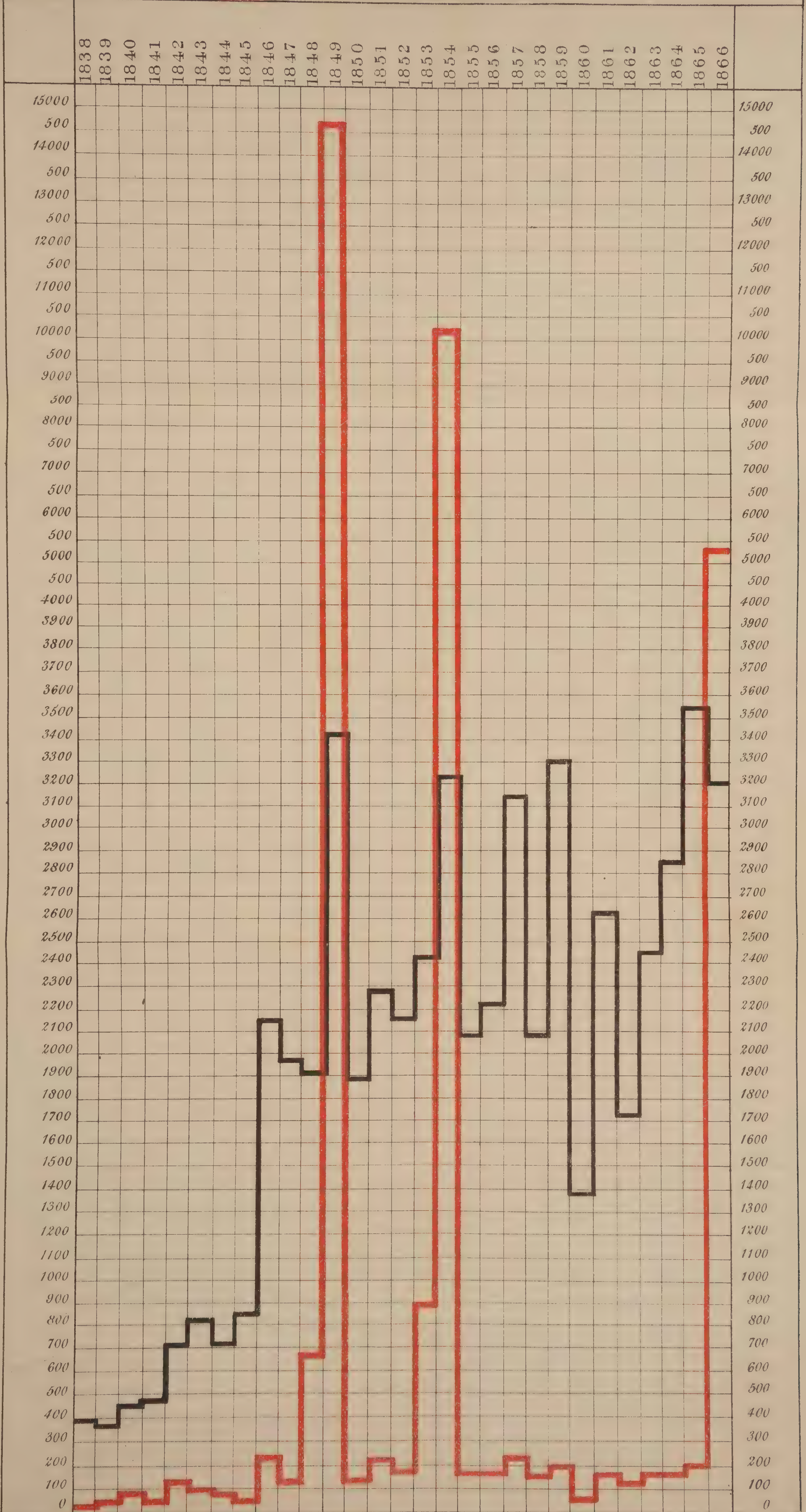
Scale, 6 Inches to One Statute Mile $= \frac{1}{10560}$

Chains 10 5 0 10 — 80 Chains } 1 Mile
Perches 40 20 0 40 — 320 Perches

I

Diagram showing the Mortality from Diarrhœa and Cholera in the Metropolis during the 29 years 1838 — 1866.

Cholera. Diarrhœa.



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II

Diagram showing the Mortality from Cholera and Diarrhœa in the Metropolis during the Years 1866, 1854, & 1849.

Cholera. Diarrhœa.

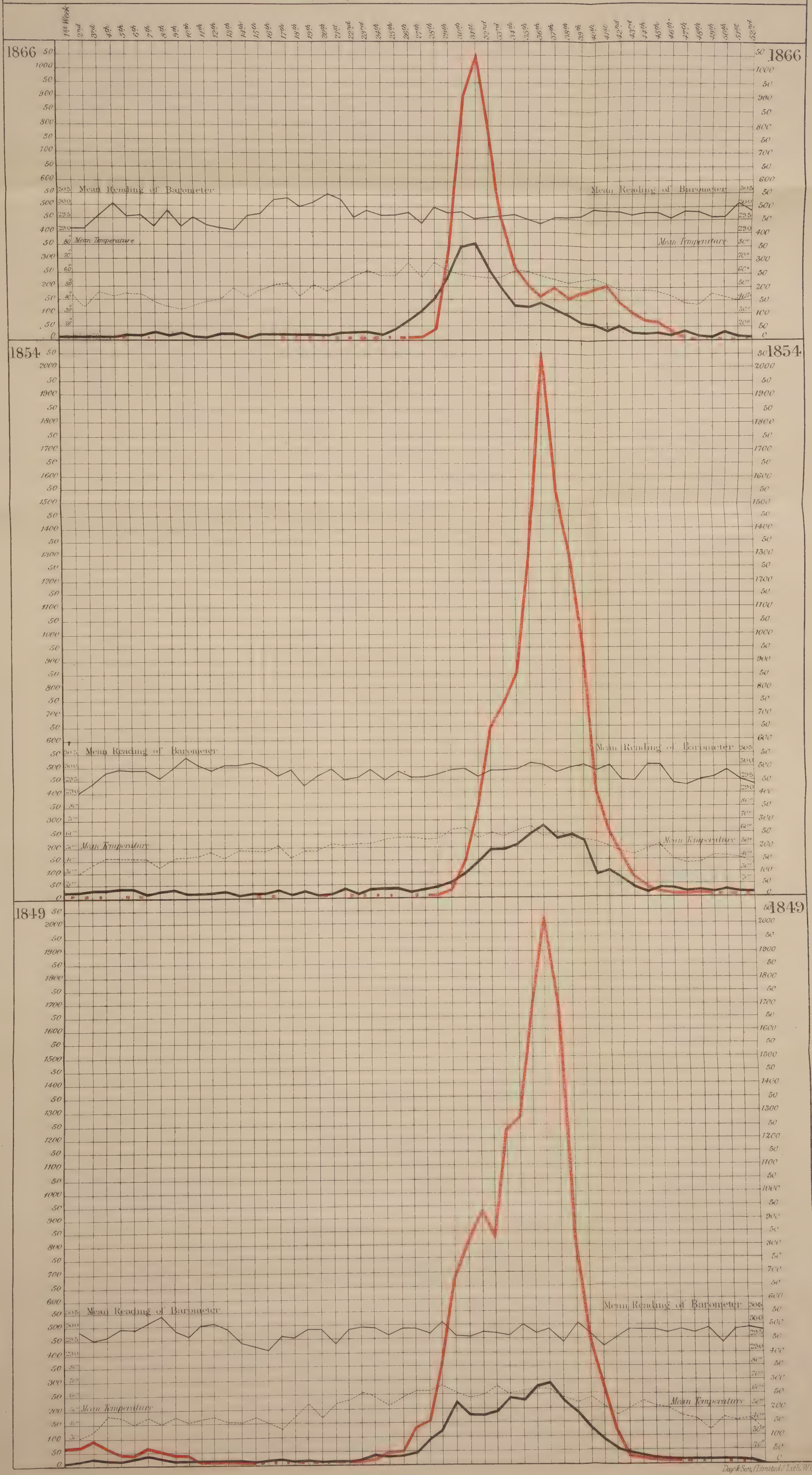

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DIAGRAM REPRESENTING THE DEATHS FROM CHOLERA AND DIARRHŒA IN EACH WEEK OF THE SIX MONTHS FROM JUNE TO DECEMBER, 1866, INCLUSIVE; WITH THE METEOROLOGICAL PHENOMENA REGISTERED AT GREENWICH IN THE CORRESPONDING WEEKS.

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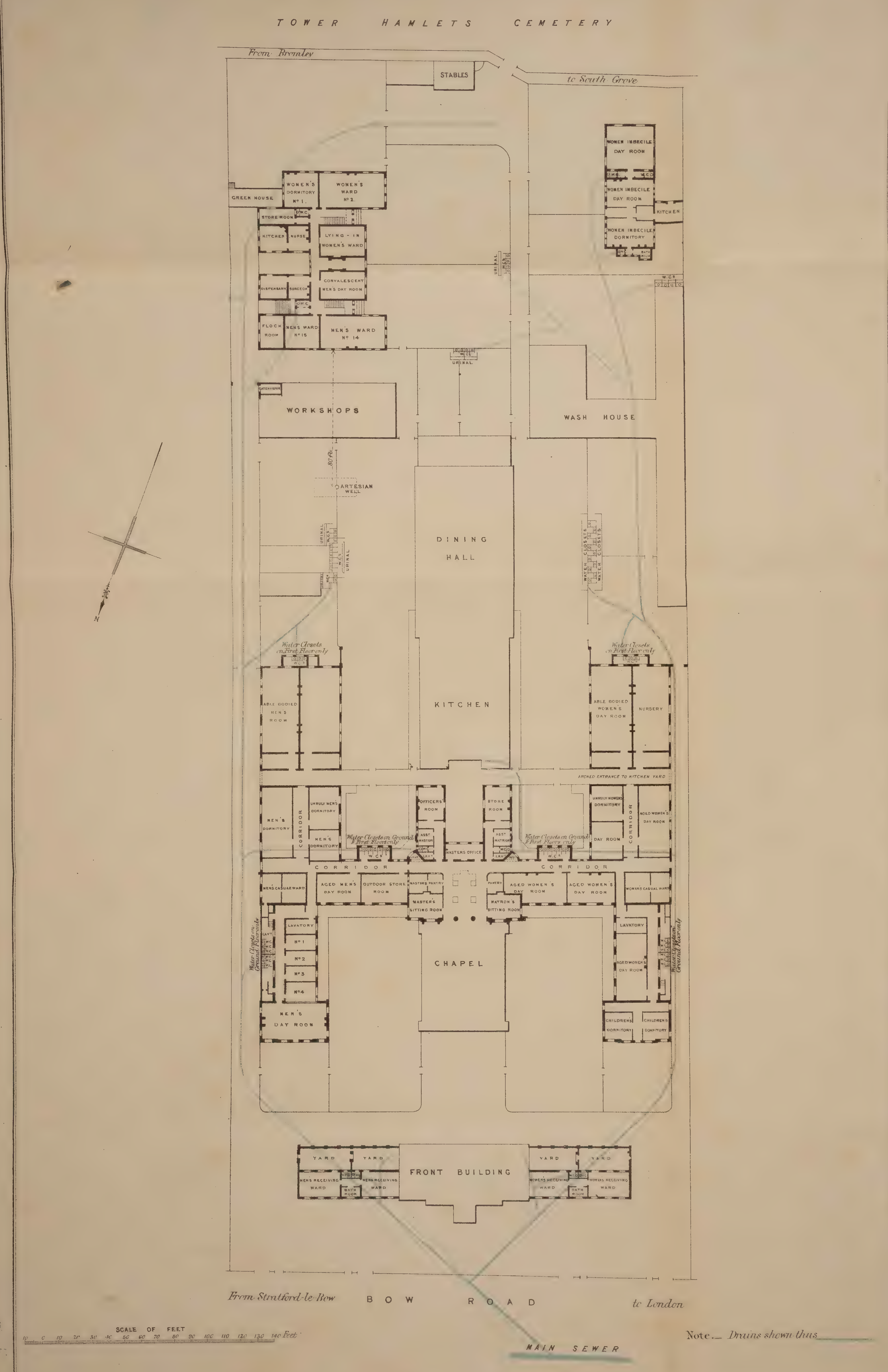
BLOCK PLAN OF THE CITY OF LONDON WORKHOUSE.



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